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SUPPLEMENTS TO THE BULLETIN OF THE HISTORY OF MEDICINE

Editor: HENRY E. SIGERIST
Associate Editor: GENEVIEVE MILLER

No. 4

MALARIA

IN THE

UPPER MISSISSIPPI VALLEY

1760—1900

BY

ERWIN H. ACKERKNECHT

BALTIMORE
THE JOHNS HOPKINS PRESS
1945

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PREFACE

> Such are the results which I have obtained, at the expense of no little time and labor, and which I offer as an answer to the question proposed by the Committee. Imperfectly as the facts may cover the vast area thrown open, I have at least the consciousness of having explored some neglected sources of knowledge, and of having rescued a few perishing traditions from forgetfulness. The difficulty of the task I have undertaken will hardly be realized excepting by such as may have made the same attempt; and if another should prove more successful than myself, I will not envy him the annual laurels, for they will seldom be more dearly purchased than by the wearied student who obtains them after the toils of this harassing investigation.
>
> OLIVER WENDELL HOLMES, 1836.

> What I have collected and presented, has required more labor than many of our brethren might suppose; and yet, they will not, perhaps, realize so fully as I do myself, how much must be added—how many errors corrected—before the pages through which they have traveled, can be entitled to universal acceptance.
>
> DANIEL DRAKE, 1850.

As these quotations from Holmes and Drake show, the task of writing on the history and epidemiology of malaria has never been an easy one. The feelings of authors after completing such studies seem not to have changed considerably during the last 100 years, and the present writer is thus to a large extent saved from formulating himself the excuses which usually form the better part of an honest preface by simply quoting his august predecessors.

The following monograph is foremost an epidemiological study. For this purpose its dry factualness may be more or less adequate. But the author is well aware that, on the other hand, his subject matter is also part and parcel of one of the most fascinating episodes in human history: the conquest and settlement of the West, the great continental heart of North America. I have little hope that in the limits of this specialized study I have been able to combine medical research with colorful picturing of the great adventure, or to do justice to the larger and more romantic aspects of my problem. With apologies for this shortcoming, I invite the

reader to use a little bit of his own imagination and not to forget the great human drama that is hidden behind the rather dry statistics and quotations which will be found on the following pages. While I do hope to have collected the significant data on my subject, I cannot hope to have completely exhausted the material. There might still be hidden here and there valuable data in some long forgotten medical journal or pamphlet. This is one of the reasons why I did not give at the end the customary lengthy " bibliography " which pretends to be complete, but limited myself to a list of books and articles which are actually quoted in this treatise. The other reason is that in preparing this monograph I have read dozens and dozens of books or articles which, though dealing with malaria in the United States during the 19th century, either are purely clinical in nature and therefore irrelevant for our subject, or which are of no value whatsoever. To list those titles for the mere pleasure of presenting a long bibliography seemed to make little sense.

Even to obtain my modest results I needed and obtained the generous help of such a great number of persons that it is technically impossible to list them all. This does not mean that my gratitude is less hearty for those anonymous helpers than for those to be mentioned by name.

For information and advice I am particularly indebted to Mrs. Lily Hanvey Alderson, St. Louis, Mo.; Mr. R. W. Bacon, New York City; Dr. C. E. Black, Jacksonville, Ill.; Dr. E. E. Brooke, Memphis, Tenn.; Miss Lois M. Fawcett, St. Paul, Minn.; Dr. C. A. Harper, Madison, Wis.; Dr. C. F. Jordan, Des Moines, Iowa; Prof. J. T. LeBlanc, Cincinnati, Ohio; Prof. E. W. Lehmann, Urbana, Ill.; Prof. J. T. McClintock. Iowa City, Iowa; Dr. O. McDaniel, Minneapolis, Minn.; Prof. W. J. Petersen, Iowa City, Iowa; Prof. W. A. Riley, St. Paul, Minn.; Dr. R. Schlueter, St. Louis, Mo.; Dr. F. C. Shoemaker, Columbia, Mo.; Mrs. C. M. Simons, Cincinnati, Ohio; Dr. Jeannette Dean Throckmorton, Des Moines, Iowa; Dr. George Urdang, Madison, Wis.; Dr. H. A. Whittaker, Minneapolis, Minn.; Dr. L. L. Williams, Jr., Washington, D. C.; Prof. S. A. Witzel, Madison, Wis.

Dr. Fruma Wolfson of Baltimore has had the great kindness to read the manuscript and to give me her expert advice. Mr. Harold Ward of New York has done his best to improve on my linguistic shortcomings. Miss Helen Wheeler of the W. H. Welch Medical Library, Baltimore, has given invaluable help in tracing and making accessible literary sources. Mrs. Janet Brock Koudelka has heroically borne the burden of typing a

very extensive correspondence, necessitated by this study, and the manuscript. The Cinchona Products Institute of New York (Director, Norman Taylor) has by a grant financed the fieldwork and part of the expenses incurred. My former teacher, Prof. Henry E. Sigerist of Baltimore, has generously given advice and encouragement in this, as in all my former adventures in research. To all these kind helpers I wish to express my heartiest gratitude.

I would never have completed this, or any other study, without the constant encouragement and patient understanding of my wife, Lucy Kruger Ackerknecht.

ERWIN H. ACKERKNECHT

The Johns Hopkins Institute of the
History of Medicine

September, 1944.

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INTRODUCTION

Malaria, which persecuted Louis XIV and his house, which killed James I and Cromwell, no longer affects dramatically the great and the mighty. But still, "from the standpoint of prevalence malaria appears to be the most important disease in the world today." [1] The yearly number of cases throughout the world has been estimated at 300 millions and the number of deaths at 3 millions.[2] This would mean that one sixth of the earth's population is suffering from malaria. Other estimates go even up to one third of the global population.[3]

In the United States, in spite of 30 years of intensive anti-malarial measures and notwithstanding great successes in this field, the yearly incidence of malaria lies between one and six million cases with an average of four millions per year.[4] Even the most conservative estimate allows one million cases and 5,000 deaths per year.[5] The yearly economic losses are of the order of $500,000,000 and the direct cost of sickness as much as $51,000,000.[6] As American troops so far have been operating predominantly in heavily infected regions, malaria is our number one medical problem in the present war,[7] and its victims may provoke, at least during some years, a new wave of malaria in the United States.

Malaria research, therefore, does not need any excuse today. The historical approach seems justified by the fact that epidemiology is, more than any other branch of medicine, unable to rely exclusively on the laboratory and can still learn much from the records of history's cruel and gigantic "experiments." Even such a great experimentalist and active preventionist as R. Ross thought that "an historical introduction is always necessary to give coherence to ideas." Barber states that "a study of the history of malaria in a country may afford useful information as to the best means of combating the disease." [8]

The Upper Mississippi Valley was chosen for examination as a region

[1] Stitt Strong, 1942, p. 1. See also McKinley, 1935, p. 379. *When not given in the text or footnote the exact title of books and articles quoted is to be found in an alphabetic list at the end.*

[2] Russell, P. F., 1943, p. 601.

[3] Talliaferro, 1944, p. 55.

[4] L. L. Williams, 1941, p. 367.

[5] Coggeshall, 1943, p. 9.

[6] L. L. Williams, 1941, p. 367.

[7] Talliaferro, 1944, p. 55; Simmons 1942, p. 30 ff.

[8] Barber, 1930, p. 13.

where malaria, after having been once very prevalent, had disappeared spontaneously long before the introduction of any systematic antimalarial measures; and where, therefore, new insight into the mechanism of the rise and fall of malaria might be gained. " In the North the decrease in malaria seems to have come about quite independently of any conscious effort on the part of the health agencies. It had nearly disappeared by the time that the method of transmission of the disease by mosquitoes was discovered." [9]

The method of transmission was discovered by R. Ross in 1897. Although Americans under Gorgas and Le Prince had started large scale anti-mosquito campaigns as early as 1901, first in Cuba, then in Panama, active suppressive measures in the continental United States did not begin before 1912.[10] The first extensive malaria control plan in Mississippi dates from 1915.[11] L. O. Howard's report in Ross' *Prevention of Malaria* on measures taken before 1910 shows their scanty, sporadic and incidental character, the methods being directed rather against insect nuisances than against disease.[12]

The expression " disappearance of malaria from the Upper Mississippi Valley " needs an explanation. This Valley is regarded generally as lying above the entrance of the Missouri, i. e. upwards from Alton, Illinois. Yet for technical reasons it is impossible to deal with the region thus defined since all historical, statistical and other records are compiled on the basis of states. We therefore have to take state divisions as our point of departure and *actually deal in the following with the history of malaria in the five States bordering the Upper Mississippi: Minnesota, Wisconsin, Iowa, Illinois and Missouri.* But the two latter states actually transgress the Missouri line, and therewith the Upper Mississippi Valley in the strict sense of the word, and reach down beyond the Ohio. These very regions of Southeastern Missouri and Southern Illinois include several counties which have never ceased to be heavily endemic foci of malaria.

In 1909-1913 ten counties, i. e. one tenth of the counties of Illinois, all located in the southern part of the state (Alexander, Gallatin, Johnson, Madison, Massac, Pope, Saline, St. Clair, Union, Williamson) claimed 235 or *50 percent of all malaria deaths* in the state during this period (572 deaths). [13] In 1927 the death total went down to 63, but our ten countries still were responsible for half of the deaths (30).[14] In 1939 the

[9] *Ibid.*, p. 12; see also Boyd, 1930, p. 5.
[10] L. L. Williams, 1941, p. 367.
[11] Underwood and Whitfield, 1938, p. 69.
[12] Ross, 1910, p. 333 ff.
[13] Ezdorf, 1915, p. 11.
[14] XI Ann. Rep. Ill. Dept. Publ. Health, p. 195.

number of deaths was 35 and the state malaria death rate 0.43 per 10,000; but the southern section which comprises our 10 counties has a death rate of 1.39 as compared to 0.09 of the central and 0.36 of the northern section.[15] In Southeastern Missouri we are faced by the same phenomenon. While the malaria death rate of the state was at 1.54 per 10,000 in 1910 and at 0.4 in 1920, seven southern counties, i. e. six percent of Missouri's counties, in 1911-1914 had a death rate of 5.6 in 10,000,[16] and in 1919-1921, a rate of 4.8.[17] Yet because of our caution in using statistics and the small percentage the respective counties represent in the total states, the influence of this factor on our general study will be less than might be expected.

While the foregoing paragraphs give a more precise sense to the expression "Upper Mississippi Valley," the term "disappearance" still needs an explanation, being—even quite apart from the foci in Southern Illinois and Southeastern Missouri—only of conditioned exactness. Actually malaria has never totally and literally disappeared from any larger region once it has really penetrated it. It has only *decreased* to such insignificant proportions as practically justify the expression *disappearance*. This holds good for England, France, Germany, the Netherlands, Denmark, etc.[18] And this is equally true for Minnesota, Wisconsin, Iowa and the greater parts of Illinois and Missouri.

The report of the Interstate Malaria Survey between Alton, Illinois, and St. Paul, Minnesota, issued by the Board of State Health Commissioners in 1943 gives the following morbidity rates:

	1940	1941
Wisconsin	3 cases from 3 places	1 case
Minnesota	2 cases from 2 places	2 cases
Iowa	46 cases from 8 places	20 cases
Illinois	45 cases from 7 places	42 cases
Missouri	249 cases from 5 places	37 cases
	(233 cases from Hannibal alone)	

Although these figures differ slightly from the total figures given in personal communications of Dr. C. A. Harper (Wisconsin), Dr. O. McDaniel (Minnesota), Dr. C. F. Jordan (Iowa), and in reports of State Boards, they give a fair picture of the general situation of practical disappearance.

[15] XXIII Ann. Rep. Ill. Dept. Publ. Health, p. 220.
[16] F. L. Hoffman, 1917, p. 53.
[17] Maxcy, 1922, p. 1129.
[18] Malaria Comm., 1927, p. 12.

On the Shortcomings of Malaria Records

It has been, of course, our intention to give to this study not only a qualitative, but also a quantitative character. This latter intention has been defeated by the nature of the documentation at our disposal. There are some very serious reasons which make quantitative studies of the past history of malaria and the factors of its decrease impossible. Previous local medico-historical studies are almost nonexistent since most medical historians have the fatal tendency to write rather the history of doctors than the history of medicine and disease. During the 19th century, particularly under frontier conditions, there was no official and very little unofficial recording of diseases and, to make things worse, just as its height malaria (or "fever and ague," the "chills," intermittent, remittent, bilious fever or whatever it was called)[19] was so common that by many it was no longer regarded as a disease at all and therefore, of course, not recorded as such. In the beginning the "chills" were regarded as a necessary element of the inevitable "acclimatization" and after having "shaken" for years people got so used to it that they hardly paid attention to a little "ague." This is a classic example of how an objectively dangerous and burdensome bodily condition can subjectively, by social convention, even lose the character of a disease.[20]

Travellers often omitted mentioning malaria as in corresponding situations they often omit mentioning seasickness or mountain disease, taking them for granted. They were, as are the historians, predominantly interested in political conditions. Especially the women, like F. Bremer or H. Martineau, were so fascinated by the slavery question that there was little attention left for anything else: why worry about a little shaking when murderous and highly dramatic epidemics of cholera and smallpox repeatedly swept through the Valley? Timothy Flint, the Massachusetts missionary and herald of the frontier, in his early classic on 19th century frontier conditions, makes the following significant statement:

> The valley of the Arkansas, with very little exception, is sickley. Remittents and intermittents are so common, that when a person has no more than simple fever and ague, he is hardly allowed to claim the immunities of sickness, and it is

[19] Drake (II, 17) gives the following list of synonyms for malaria: autumnal, bilious intermittent, remittent, congestive miasmatic, malarial, marsh, malignant, chill fever, ague, fever and ague, dumb ague, and lastly, *the* fever.

[20] For this problem see Ackerknecht, E. H., Primitive Medicine and Culture Pattern, *Bull. Hist. Med.*, XII, p. 554, and Ackerknecht, E. H., Psychopathology, Primitive Medicine and Primitive Culture, *ibid.*, XIV, p. 36.

remarked that he has only the ague. The autumn that I was there, it appeared to me that more than the half the inhabitants, not excepting the Creoles, had the ague.[21]

Buley quotes the same expression for pioneers of a slightly later period: "He ain't sick, he's only got the ager." [22] In 1813 a letter of a Norwegian settler in Mitchell County, Iowa, says: "There was no fever, except ague, which troubled us some." [23] Corson (1888) still stated that the expression of "bad feeling" may cover actually an attack of malaria. Professor T. J. LeBlanc was kind enough to confirm for me the same observation from his childhood experience in Michigan. It is sometimes difficult to decide whether so many of the early gazetteers or newspapermen omitted so completely to mention malaria, although it was obviously prevalent in their region, for the above mentioned reasons or because they were materially interested in the fact that the region which they wanted to have settled should be regarded as healthful.

Especially the malaria of small children, which constitutes the bulk of malaria cases in highly endemic sections, went unnoticed, at least by medical men. What Hippocrates and Aristotle had known was forgotten.[24] There was even a widespread belief among doctors that malaria only attacks adults.[25] Dr. Sappington of Missouri, who was one of the few to realize that infants might suffer from malaria, came on the other hand to the erroneous conclusion that "cholera infantum" was but a form of bilious (malarial) fever.[26] Laymen sometimes seem to have been better observers of infantile malaria as the following piece from a memoir of the 1830's shows:

As we drew near Burlington [Iowa] in front of a little hut on the river bank, sat a girl and a lad—most pitiable looking objects, uncared for, hollow eyed, sallow faced. They had crawled out into the warm sun with chattering teeth to see the boat pass. To Mother's inquiries the captain said: "If you've never seen that kind of sickness I reckon you must be a Yankee. That's the ague. I'm feared you will see plenty of it if you stay long in these parts. They call it here the swamp devil and it will take the roses out of the cheeks of these plump little ones of yours mighty quick. Cure it? No, Madam. No cure for it: have to wear it out. I had it a year when I first went on the river." [27]

There is also little doubt that actually the deadly "dysentery" of babies

[21] T. Flint, 1826, p. 256.
[22] Buley, 1933, p. 499.
[23] Hektoen and Gjerset, p. 11.
[24] Jones, 1907, p. 41.
[25] E. Bartlett, 1847, p. 345.
[26] Sappington, 1844, p. 112.
[27] Petersen, Doctors, 1938, p. 402.

in Coldwater, Michigan, which so readily subsided after the destruction of a mill dam, was malaria.[28]

One difficulty of writing the history of malaria for a given region has already been signalized by Oliver Wendell Holmes: the disease may have been contracted in a place far distant from the one where it breaks out.[29] The greatest difficulty arises, of course, from the differences between our nomenclature and clinical notions of the disease and those of the 19th century physicians and laymen. To us malaria is a disease clearly ascertainable by the presence of plasmodia in the thick blood smear. To 19th century physicians malaria was and could be but that mysterious emanation of swamps and "decaying vegetable matter" which caused "malarious" or "estivoautumnal" disease: a rather elastic entity which, according to the temperaments of the respective authors, embraced almost everything from yellow fever and cholera to influenza and dysentery. "Chills," "swamp fever," "fevers," "fever and ague" are hardly less vague expressions. Even encountering more precise clinical terms like intermittent, tertian, quartan, remittent, remittent bilious, or congestive fever, we must be well aware of the fact that although generally regarded as synonyms of our malaria, they can only be partly counted on to coincide with it. Except perhaps for intermittent and tertian fever, all of them very often, especially in the second half of the 19th century, included cases of typhoid fever in the north and yellow fever in the south, or vice versa.[30] The leaders of the medical profession were very early aware of this danger. Austin Flint published in 1847 in the *Buffalo Medical Journal* a widely reprinted article on the distinctive character of remittent, typhoid and typhus fever.[31] T. D. Mitchell explained in 1846 that malaria was often diagnosed as typhoid complaints.[32] In all justice it must be realized that as long as the plasmodium was unknown even the autopsy was confusing, some of the outstanding pathological features in spleen, liver and bone marrow being common to both typhoid and malaria.[33] Even after the discovery of the parasite admonitions on the basis of diagnostic failures keep going on. In 1896 Roskoten emphasized the possibility of diagnosing malaria by an old habit when actually typhoid, sinusitis, otitis media,

[28] J. H. Beech in Bowditch, 1877, p. 177.

[29] Holmes, 1838, p. 2.

[30] The confusion between typhoid and malaria confronts every historian of malaria. See Jones, 1907, p. 28.

[31] Austin Flint, *Missouri M. S. J.*, 1847, p. 209 ff.

[32] T. D. Mitchell, *Missouri M. S. J.*, II, 1846, p. 111.

[33] P. R. Cannon, 1941, p. 216.

meningitis, pulmonary tuberculosis or pyosalpinx may be involved.[34] In 1909 J. P. Bates states that "mild typhoid fever is constantly called malaria."[35] According to M. Boyd, one of our leading malariologists, the confusion between typhoid and remittent fevers lasts almost to this day and he has pointed to the decrease of "malaria" in North Carolina since the introduction of—typhoid vaccination.[36]

Striking examples of the confusion between other fevers and malaria are plentiful all through the 19th century. When in the 1830's Sappington cured a case of "typhoid" with a few grains of quinine, there seems to be little possible doubt what he actually cured.[37] R. Morton and Torti had given advice as early as 1692 and 1712 on how to differentiate malaria from other fevers by its prompt reaction to the bark.[38] Lesser men in later times unfortunately drew the opposite conclusion and thought quinine a specific e. g. for yellow fever when their "yellow fever" cases reacted favorably to quinine instead of reversing their diagnosis of "yellow fever" in favor of malaria.[39] An examination of Drake's reports likewise reveals a large amount of typhoid fever under the banner of malaria—"the chief mortality is from the remittent type, in its progress becoming typhous."[40] Dr. Riley of St. Paul has drawn my attention to a very typical article of H. H. Wilcox in the *Northwestern Lancet* (vol. VI, 1886, pp. 43-45) on a "snug little case of malarial fever of the typhoid nature." The work of the Walter Reed - V. C. Vaughan - E. O. Shakespeare Board in 1898 during the Spanish-American War revealed that sometimes 100 percent of the "malaria" cases in military camps were typhoid.[41] Thayer showed in 1897 the ratio of typhoid and malaria death rates in the Johns Hopkins Hospital as being 16:1, while in the city of Baltimore they were 1:1; a contradiction hardly explainable but by faulty diagnosis in the city.[42]

At the basis of the confusion between typhoid and malaria seems to lie a definite epidemiological event. Reynold in his *Pioneer History of Illinois* (p. 315) writes, referring to the American Bottom in Illinois:

[34] Roskoten, 1896, p. 135.
[35] J. P. Bates, 1909, p. 820; for the "Problems of Clinical Diagnosis" see also Hoffman, 1918, p. 46.
[36] M. Boyd, 1930, p. 4.
[37] Sappington, 1844, p. 83. [38] Ross, 1910, p. 7.
[39] E. g. Dr. Steven from St. Croix, quoted by Sappington, 1844, p. 122; Dr. Stone, *St. Louis M. S. J.*, 1856, p. 173; Surgeon General Lawson, quoted by Sappington, 1844, p. 136.
[40] Drake, 1850, I, p. 303.
[41] Reed, 1905, p. XV. [42] Thayer, 1897, p. 3.

> The country at that day [around 1800] was more sickly than it is at present; but the only disease then was the bilious fever, with pleurisy at rare intervals. The bilious attacks showed themselves mostly in the forms of fever and ague. The fever without the ague or some chill with it was not frequent. These diseases attacked the people in the latter part of the summer and in the fall and were very common, but not often fatal. The sickness at this time [1852] is not so common, but more malignant and dangerous. Many in the olden times were sick in the fall, but few died. By improvement or some other means the diseases of the country have changed within the last fifty years to be much fewer cases but more fatal.[43]

An unprejudiced reading of this interesting passage suggests that around the 50's malaria was already on the decrease in Illinois, but replaced by typhoid. We feel encouraged in this hypothesis when two outstanding 19th century American epidemiologists, G. Sternberg and R. Bartholow, make the following statements:

> There is good authority for the belief that malarial fevers have a tendency to disappear as countries become more populous and that they are superseded to a certain extent by enteric fevers.[44]

> I have always adverted to the fact that as population increases in malarious districts typhoid supplants the intermittent and remittent fevers.[45]

This fact could be recognized as in the source of Zeuch, who states that after 1847 in St. Charles, Kane County, Illinois, intermittent and remittent fevers were replaced by typhoid;[46] or as by Dr. Nance of Stark County, Illinois, who tells us that since 1849 "gastroenteritis with chills" was seen instead of ordinary remittents and intermittents, that this syndrome was quinine-resistant, and that since 1847 typhoid had spread all over the West.[47]

But the doctor could also continue his routine of diagnosing "malaria" when actually he was faced by typhoid. Most doctors seem to have done so and C. B. Johnson seems right when he states in his *Sixty Years in Medical Harness* that, although there was in the 60's a general prevalence of malaria around Chatham, Illinois, most physicians overdid the recognition of this disease.[48] Thus we see that malaria could be not only underestimated ("no disease") but also overestimated. This little historic digression shows us that, important as malaria was in the Upper Missis-

[43] Zeuch, 1927, p. 76.
[44] Sternberg, 1884, p. 23.
[45] R. Bartholow, *Mem. U. S. San. Comm.*, Med. Vol., p. 126, N. Y., 1857. For more sources on this question see Hirsch, I, 480.
[46] Zeuch, 1927, p. 560.
[47] Nance, 1853, p. 57, 58, 56.
[48] C. B. Johnson, 1926, p. 96.

sippi Valley during the 19th century, typhoid must have played sometimes a hardly less important, although less recognized role.

The confusion between malaria and typhoid fever reached its peak and became official when J. J. Woodward in 1862 created his notion of "typhomalarial fever." [49] The trouble was that Woodward was not just a provincial crackpot, but one of the outstanding army surgeons of his time, coauthor of the *Medical History of the War of the Rebellion*, collaborator of the census, a very learned man who sold his ugly hybrid even to men like Virchow, Dickson, Wood and Drake and, of course, introduced it into the census statistics; [50] Hirsch's passages on typhomalarial fever show how widespread Woodward's theory was in the 1880's. Only the 20th century delivered us from this phantom.

It is, of course, possible to argue that nothing changed in the occurrence of typhoid and malaria in the 50's, and at the basis of the passages quoted by us is simply the fact that typhoid, now being for the first time clearly defined and delineated, was more readily and often diagnosed than it had been before. The observations submitted above, and others which are given in the chapters on the individual states, nevertheless incline the author towards the opinion that actually such a shift from malaria to typhoid took place in the 1840's and 1850's.

What statistics are worth under such confused conditions can be easily imagined. Besides, morbidity statistics—which in the case of malaria, a disease that ruins but rarely kills, are the only significant ones—are nonexistent for the 19th century except for the army. The Medical Corps of the U. S. Army has the great merit of having made morbidity statistics available since 1819.[51] But quite apart from the diagnostic errors which spoil all 19th century statistics, the fact that military formations were continuously moving from one Fort to another, and that malaria contracted in the South might thus appear under a Western locality makes them of only limited value to our regional study.

In 1876 H. I. Bowditch in his classic on *Public Hygiene in America* (Boston, 1877) declares regretfully the census death statistics, especially as far as the classification of death causes is concerned, to be worthless.[52] The Compendium of the Xth Census (I, p. XXXIII, Washington, 1885) itself concedes that in 1870 41 percent of the deaths occuring in that year escaped record. The Census Mortality Statistics of 1910 (XI Ann. Rep.; Washington, 1913, p. 27 ff.) gives the following edifying example of

[49] Woodward, 1876, p. 12.
[50] Hirsch, 1881, p. 166 ff.
[51] U. S. Army, 1840.
[52] P. 115-116.

" the very considerable degree of uncertainty with respect to the returns of deaths from malaria." Richmond, Virginia, showed from 1904 to 1907 the surprisingly high malaria death rate of 23.1 in 100,000 population. An investigation showed that the malaria death returns emanated exclusively from three out of the more than 200 physicians of the city. The three were " respectfully requested to avoid using the term of malaria to cover those cases of fever in which they had failed to find any other cause." In 1908-1911 the Richmond malaria death rate dropped to 2.4 in 100,000. Under these conditions one can hardly disagree with Hoffman, when in 1917 he calls statistical returns on malaria " inadequate." [53] Still in 1941 J. Andrews states: " Deaths from malaria are generally overreported." [54] The Malaria Commission of the League of Nations thinks that malaria mortality statistics " do not provide a good method of ascertaining the distribution and character of malaria and that the results of their use as an indicator of success in antimalarial measures may be very misleading." [55] And M. Boyd says: " Official vital statistics as the term is usually understood have a less practical value for malaria than perhaps for any other disease." [56] Modern malariologists therefore base their work almost exclusively on special surveys.

The impossibility of a quantitative approach is sufficiently explained by the unreliability of transmitted diagnoses, the lack or inadequacy of statistics, and the fact that most cases of malaria did not even come to the attention of doctors and were treated by self-medication. Whether this latter fact was caused by the lack of doctors, as is sometimes suggested, is doubtful. In 1860 the numbers of doctors per 100,000 population were 168 for the North, 190 for the South and 240 for the Frontier.[57] In 1890 the West-North-Central Section shows about the same values as the East.[58] Perusal of earlier documents does not suggest the idea of lack of doctors, although there were certainly great difficulties in reaching the patient in the roadless regions. As early as 1839 we have even a remark on the " excess of doctors in Iowa." [59] Armstrong reports that St. Paul in 1847 with 40 inhabitants had one doctor, in 1849 with 300 inhabitants, six of them.[60] Quite another question is whether many of the early " doctors " were really devoting their time to medicine or to business, farming or politics, and what exactly was the quality of their services (and diagnoses!). We cannot forget that this was a time when many

[53] Hoffman, 1918, p. 21.
[54] Andrews, 1941, p. 285.
[55] Malaria Comm., 1925, p. 52.
[56] Boyd, 1930, p. 132.
[57] Martin, 1942, p. 226.
[58] Mayers-Harrison, 1924, p. 159.
[59] Plumbe, 1839, p. 515.
[60] Armstrong, 1942, p. 220.

doctors were not trained in medical schools, when even a medical school training did not amount to much, when e. g. the Supreme Court of Michigan ruled: "A doctor is any person calling himself such," [61] a rule valid until 1883. A keen observer and an American doctor himself came in 1861 to the devastating judgment: "The medical profession in America bears the evils of haste and irregularity incident to so many of its institutions. . . . One can scarcely conceive of an honorable profession reduced to a lower ebb than that of medicine in the U. S." [62] The historian, E. W. Martin, who in 1942 gave a comprehensive survey of the whole medical situation during the 1860's, has come to conclusions hardly more optimistic, especially as far as certain frontier doctors are concerned.[63] Only a small minority, admirable for its courage and sometimes extraordinary powers of observation, kept up the standards of the profession.

Pathological Theories concerning the Cause of Malaria in the U. S. prior to Laveran's Discovery

Before commencing the systematic study of malaria records, emanating mostly from medical men, and for a better understanding of these records, it may be useful to recapitulate briefly the theoretical concepts of medical men around the middle of the 19th century in so far as the causation of malaria is concerned. The book of G. Sternberg, the late Surgeon General, on malaria, published in 1884, graphically shows how confusing the malaria problem was even to a most excellent man before the recognition of the discoveries of Laveran and Ross. The lack of real knowledge was keenly felt. "The subject [of malaria] however is still enveloped in deep obscurity, and to him fortunate enough to enrich science by unravelling its mysteria, a proud immortality is destined," wrote Forry, the author of the first army medical statistics in 1841.[64] Bartlett, the author of the famous treatise on the fevers of the United States, was full of scepticism: "And what reason is there to believe or to hope that the thick darkness which has ever wrapped and which still wraps this intermittent physiological phenomenon, so full of mystery and wonder, will ever be dispelled?" [65]

In spite of 200 years of intense nosological endeavor, the classic idea of the fundamental unity of all fevers was still lingering, and the supposi-

[61] Buley, 1933, p. 510.
[62] Nichols, 1937, p. 225, 227; see also Garrison [1933], p. 161, on this situation.
[63] Martin, 1942, p. 230.
[64] Forry, 1841, p. 46.
[65] Bartlett, 1847, p. 381.

tion that a malarial fever could transform itself in the course of the disease into yellow fever or typhoid seemed neither absurd nor revolting.[66] The writings of Sappington, Palmer, Vethake, or even T. D. Mitchell, for instance, show still the earmarks of this creed.

The governing theory among practitioners up to the time of Laveran (and even later) was that malarial fevers were caused by "bad air" ("mal'aria"), a poison or miasma exhaled by decaying vegetable matter, especially by swamps, which poison produced a more or less definite clinical and anatomical picture (periodicity of fever, enlarged spleen, etc.). This theory, already proffered in antiquity, had been firmly established by Richard Morton (1692) and Lancisi (1717), when the discovery of cinchona and the increase and spread of malaria in the age of discoveries had given new impetus to the study of malaria. Most malarious localities were marshy indeed. The theory explained the healthfulness of dry summers,[67] the bad effects of the building of mill ponds or clearing, and the effect of winds, spreading the disease in certain directions.[68] But in the first half of the 19th century a continuously increasing number of observations of "marshes without malaria," [69] and "malaria without marshes" [70] (somewhat related to the later puzzling problem of "Anophelism without malaria") began to produce independently both in Europe and in the United States a healthy doubt of the old theory. Americans did not deceive themselves by the all too clever explanation of some French authors that *all* malaria cases in non-marshy districts had resided before in swamp regions (Bally, Bretonneau, etc.).[71]

This led to a renaissance of the animalcular hypothesis of disease in America which paralleled a similar movement in Europe (Henle, 1840; Rasori, 1846). Local conditions in the United States made intermittent fevers and yellow fever the outstanding test cases for the hypothesis.

The first promotor of the animalcular hypothesis in America was John Crawford (1746-1813), an Irish physician who spent the last 17 years of a long, eventful and useful life in Baltimore. There Crawford published in 1806 and 1807 in a little literary journal edited by his daughter, *The Observer and Repertory*, a series of articles: "Remarks on Quarantine,"

[66] *E. g.* N. Webster, 1800, I, p. 530.
[67] Cooke, 1829, p. 3.
[68] *Ibid.*, p. 7.
[69] *Med. Examiner*, VI, 1843, p. 269; McCartney in *St. Louis M. S. J.*, XIV, 1856, p. 105; Knode, *ibid.*, p. 411; Wilson-Smith, 1816, p. 74.
[70] Dunglison, 1844, p. 69; T. Flint, 1826, p. 259.
[71] Groussin, 1831, p. 6-7.

where he expounded the animalcular hypothesis of epidemics.[72] The only result of Crawford's pioneer work seems to have been that he was regarded as a crackpot and, as he says, "deprived of all the valuable practice in this city."[73]

A more successful protagonist whose terminology and reasoning is closely followed by later partisans of the new animalcular school in the United States is the anonymous reviewer of McCulloch's *Malaria* in the *American Quarterly Review* (vol. IV, Philadelphia, 1828, pp. 286-308). He knew the work of Crawford, but claims to have developed his animalcula hypothesis independently and on different grounds. He calls his disease-producing, microscopic animalcula, which he opposes to McCulloch's miasma or marsh poison, "insects," which is slightly disturbing.[73a] He gives 32 points in favor of the animalcula hypothesis. As he seems to be little known, it may be worthwhile to quote a passage where he notes the coincidence of "insects" and malaria:

> The times and seasons, the places and circumstances, where miasma abounds, are the same as where insects abound. Universally so . . . Insects are of all sizes from the largest to the myriads of various kinds, which nothing but the most powerful microscope can exhibit to our sight. But large or small the laws of their production are the same. The circumstances that will produce a gnat, will produce an insect something less. (P. 303.)

The anonymous author seems to have found an echo that was denied to Crawford. Parson quotes him explicitly and Nott and Drake show unmistakably his influence.

The best known exponent of the new school is J. K. Mitchell, and rightly so. His brilliant essay on the *Cryptogamous Origin of Malarious and Epidemic Fevers* (1848) is the clearest and most complete exposition of the subject and replaces the vague "insect" notion by the much more appropriate term "fungus."[74] The interest being focused on Mitchell, it has escaped the attention of historians that other contemporary leaders of the medical profession like Bartlett,[75] Drake or Nott were animalculists too.

Drake had inclined towards the animalcular hypothesis since 1833. He applied it very ingeniously in order to explain the different forms of

[72] "The Observer and Repertory" seems to have survived only in one copy which is in the possession of the Maryland Historical Society. But the article of Futcher, 1936, contains very significant extracts from Crawford's original publication.

[73] J. Wilson, 1942, p. 69.

[73a] This custom survives even today in the popular synomym "bugs" for bacteria.

[74] Mitchell, 1859, p. 13 ff.

[75] Bartlett, 1847, p. 347.

malaria as being caused by different species of the same family of animalcula. Unfortunately he sticks to the vague "insect" notion of his forerunners. In using the visible insects for comparative purposes he almost stumbled on the rôle of the mosquito:

> It is well known that certain visible insects prey on some individuals much more than others—seem to be attracted by one and repelled by another—and we have but to grant to the invisible the same tastes and instincts, to understand that some persons may always draw swarms around them, while others escape their depradations.
>
> It has often happened that mosquitoes have been absent from the banks of the middle portion of the Ohio River, for a year, and in the next appeared in immense numbers. We have but to suppose insect forms of a parallel size, to live under corresponding laws, and the hypothesis now before us, offers an explanation of healthy and sickly seasons.[76]

Very much in the same line argues Dr. J. C. Nott of Mobile in his famous article on "Yellow Fever contrasted with Bilious Fever, etc." (*New Orleans Med. Surg. J.*, IV, 1848, pp. 563 ff.) in favor of microscopic "insects" (animalcula) as causes of yellow fever and malaria versus "miasm," "marsh poison," etc. Nott was very well aware that he did but continue the argumentation of Linnaeus, Kircher, Nyander, Ehrenberg, Wood of Philadelphia, Watson and Sir Henry Holland of London.[77]

These early American animalculists, the theoretical forerunners of bacteriology, represent a very honorable chapter in American medical history, worthy of being treated in greater detail than we are able to do in this context. Unfortunately, praise of the real merits of these men has been replaced by the creation of a widespread "Nott-myth." Nott (why not the reviewer of 1828 or Drake?), who ascribed malaria and yellow fever to the action of microscopic "insects," is credited with the promulgation of the hypothesis that mosquitoes transmit such disease-producing agents, a hypothesis of an absolutely different character and of which he actually did not think. Nott did not even express the coincidence between malaria and mosquitoes half as clearly as the anonymous reviewer of 1828 or the Roman Columella in 100 A. D., or, as about 50 years before Nott, that incomparably good observer and frightfully dangerous therapist, Benjamin Rush:

> The common house fly has nearly disappeared from our cities, moschetoes have

[76] Drake, 1854, II, 37, 40, 41.

[77] Holt, 1928, p. 500. R. Wilson's correct explanation of Nott's actual theories (*Annals of Med. Hist.*, 1931, p. 515 ff.) has unfortunately left undisturbed the propagators of the "Nott-myth."

been multiplied, and several new insects have appeared just before the prevalence of our late malignant epidemics [yellow fever and malignant tertian fever].[78]

But even this is a far cry from the hypothesis of transmission of disease by real insects, as was perhaps partly suspected by Lancisi and Crawford, but never clearly formulated before the second half of the 19th century. It seems unnecessary to credit people with ideas they did not have, when such men as Crawford, Drake, Bartlett, Nott, etc., actually did have a foreboding of the action of the malaria parasites where others could only see " poisonous gases " and " miasmas."

But we have already given rather too much time to the history of malaria theories and as a conclusion we should like to remind the reader that the fundamental historical fact is: whatever were the speculations of the " happy few," the theory of the causes of malarial fevers predominant among laymen as well as physicians up to the time of Laveran and even thereafter was the theory of the " marsh miasma."

[78] Rush, 1804, p. 175.

THE RISE AND FALL OF MALARIA IN THE UPPER MISSISSIPPI VALLEY

W. Currie begins his book on *The Diseases most Prevalent in the U. S. A.* (1811) with intermitting and remitting fevers and says:

A fever of an intermitting or remitting type or form is an endemic of America, and is more or less epidemic every year during the autumnal season in all low and moist situations in every part of the continent.[1]

And Morse's *Geography* of 1805 states:

The prevailing diseases on the lower part of the Ohio, on the Mississippi and through the Floridas are bilious fevers. In some seasons they are mild, and are little more than common intermittents; in others they are highly malignant and approach the genuine yellow fever of the West Indies.[2]

Textbooks on medical geography, memoirs, travel reports, army statistics, medical journals of the period, all agree that during the 19th century malaria was *the* American disease and, while the older states already had emerged from its worst vexations, its hotbed was what up to the 1850's was still called "the West"; the valley of the Mississippi and its tributaries. In 1829 the great English authority on malaria, John McCulloch, was even very sceptical about the possibility of ever settling the Mississippi Valley:

And in the newly settled and uncleared lands along the Mississippi and its endless tributary streams the same plague is found to prevail very widely to the surprise and serious grievance of the settlers. What the fate of this new country may be ultimately in this respect is difficult to foresee. It is to be suspected that no changes and no cultivation will ever bring it into a state of salubrity.[3]

Oliver Wendell Holmes stated in 1836 that malaria was endemic in the Western States.[4] Among medical geographers Gruel in 1868 still emphasized the malariousness of the Mississippi Valley.[5] For the 1860's Bordier came to the same conclusion.[6] In the 80's with Hirsch, Lombard and Poincaré the European reputation of the Valley was still bad.[7]

One of the most striking travelling experiences was that of Volney who

[1] Currie, 1811, p. 12.
[2] Morse, 1805, p. 764.
[3] Rawlings, 1927, I, p. 35.
[4] Holmes, 1838, p. 2.
[5] Gruel, 1868, p. 4.
[6] Bordier, 1884, p. 192.
[7] Hirsch, 1881, I, pp. 155, 159; Lombard, 1880, III; Poincaré, 1884, p. 80.

journeyed from Cincinnati to Detroit in September 1796 and on his 700 mile trip did not find 20 homes free from malaria. In 1826 Timothy Flint had the following to say concerning health conditions in the Upper Mississippi Valley:

> There are some physical disadvantages. New diseases, and the terror annexed to evils, that are colored by the imagination, the exorbitance of the charges of physicians, these are the most prominent physical difficulties. But of all the physical inconveniences of the country, exposure to the ague is undoubtedly the worst.[8]

Travelling in the West in the twenties, the children of the Hall and the Trollope families suffered from malaria.[9] In his 1861 panorama of the United States, Dr. Nichols states:

> Large portions of the newly settled country, and some of the oldest as well around New York, are full of the malaria which produces intermittent fever. In the West and Southwest there are in swamps and bottom lands, worse malaria causing violent remittent fevers.[10]

The chief source of information relative to malaria in the Upper Mississippi Valley in the first half of the 19th century is, of course, Daniel Drake's monumental *Systematic Treatise on the Principal Diseases of the Interior Valley of North America*, the result of thirty years of labor and travel. Drake paid full attention to malaria. The conclusion of his chapter on autumnal fever shows that the greatest American medical geographer regarded malaria as the most important disease of the Mississippi Valley in his time:

> The article Autumnal Fever is now brought to a close. It has extended through many pages; but a smaller number would not have sufficed to present, even an outline, of its etiological, and therapeutic history; through so wide a geographical range, as that of the southern half of our Interior Valley [that means in Drake's terminology the whole Mississippi Valley]; in almost every part of which, it is an annual endemic-epidemic. . . . It is, moreover, the *great* cause of mortality or infirmity of constitution, especially in the southern portions of the Valley, and therefore entitled to severe and patient attention.[11]

We have tried to visualize Drake's findings, as far as the Upper Mississippi Valley is concerned, by transferring them onto a map (fig. 1). Although Drake generally regarded Western Tennessee, Louisiana,

[8] Flint, 1826, pp. 238-239.
[9] Hall, 1829, III, p. 390; Trollope, 1832, II, p. 249.
[10] Nichols, 1937, p. 225.
[11] Drake, II, p. 186.

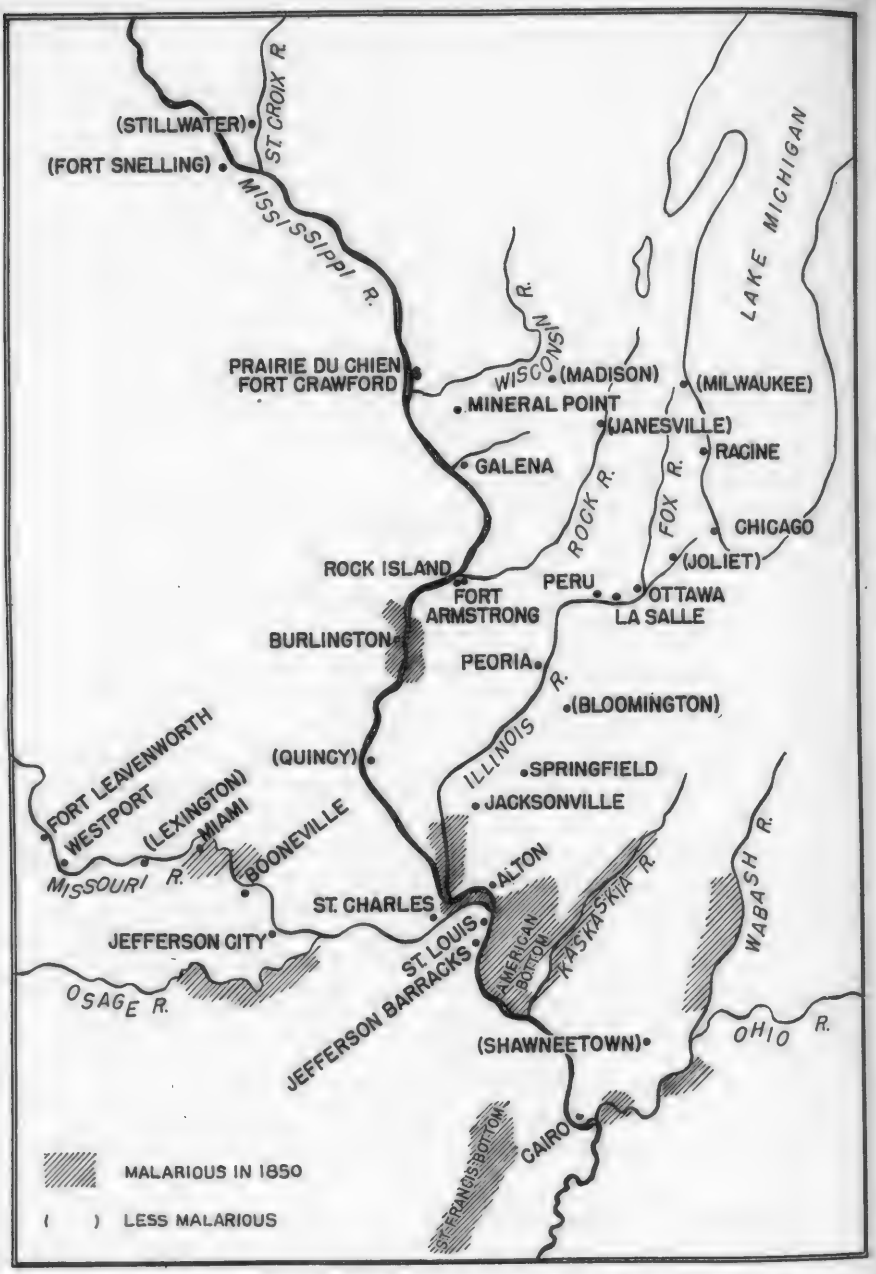


FIG. 1. Places and regions in Illinois, Missouri, Iowa, Wisconsin, and Minnesota which were mentioned by D. Drake in 1850 as being malarious.

Mississippi and Alabama as the most badly infected parts of the Valley,[12] he saw in some parts of the Upper Valley—e. g. in Jacksonville, Illinois, where conditions favorable to malaria "seemed not to prevail" and at any rate "had not prevented settlement"—cases as bad as in Alabama.[13]

The gigantic boom[14] of this large region—Missouri, Illinois, Iowa, Minnesota, Wisconsin, covering together no less than 316,470 square miles, an area almost equal to the combined surface of pre-Hitler Germany plus Poland—was accompanied by a no less gigantic boom in malaria. Malaria became a formative factor in the daily habits of people. "The minister made his appointments to preach so as to accommodate his shakes." "The Justice of the Peace entered the suit on his docket to avoid the sick day of the party or his own."[15] The common malaria problem even created an odd political alliance between the West and the South, both fighting against the custom duties on bark and quinine.

The trait which for decades most strikingly demonstrated to the traveler the malariousness of the country was the sickly external appearance of the Western settler. To give a few examples:

In 1826 T. Flint writes on the inhabitants of the Mississippi Valley above the mouth of the Ohio:

> The inhabitants seem indolent, yawning as if under the constant influence of fever and ague, which, in fact, they often have.[16]

Elsewhere he speaks of their "peculiar, cadaverous countenance."[17] The *Davenport Gazetteer* of 1836 compares the ruddy complexion of the Easterners with the paleness of the Westerners.[18] Dr. Wood (1843) is surprised by the "sallow countenance and the emaciated forms of great numbers of the country people" in the West.[19] Drake states: "Over most of the Interior Valley a ruddy complexion is rare and often replaced by a slight turbid hue or a tinge of sallowness."[20] The Washington lawyer, C. C. Andrews, notes in 1856: "It may not be proper to judge the health of a community by the appearance of people who are standing about a railroad; yet I have often noticed, when travelling through Illinois, that this class had pale and sickly countenances, showing too

[12] *Ibid.*, I, pp. 177, 216.
[13] *Ibid.*, I, p. 322.
[14] See Mark Twain, 1911, chapters 18 and 19.
[15] Burr, 1930, p. 682.
[16] Flint, 1826, p. 96.
[17] *Ibid.*, p. 29.
[18] Hall, 1930, p. 181.
[19] Wood, 1843, p. 136.
[20] Drake, II, p. 150.

clearly the traces of fever and ague." [21] Cartoons or poems like the following memorialized the phenomenon:

> And today the swallows flitting
> Round my cabin see me sitting
> Moodily within the sunshine
> Just inside my silent door;
> Waiting for the "ager," seeming
> Like a man forever dreaming
> And the sunlight on me streaming
> Throws no shadow on the floor;
> For I am too thin and sallow
> To make shadows on the floor—
> Nary shadow any more! [22]

F. H. Garrison, the great American medical historian, has condensed all such observations into an amusing verbal cartoon of the American of the period:

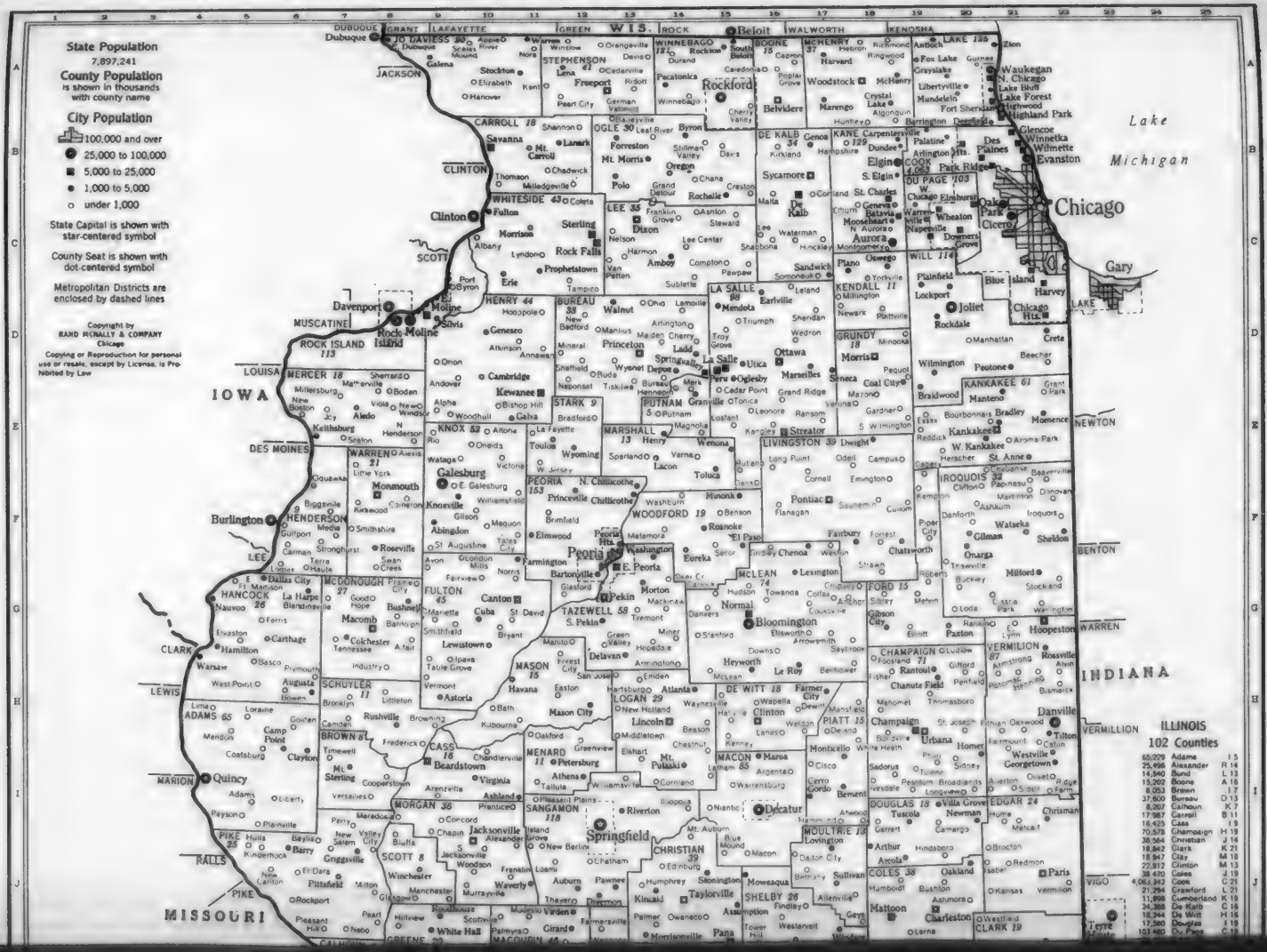
> He was literally hamstrung by the malarial and so called typhomalarial fever, while . . . bad dietetic habits . . . or the consumption of strong waters in the morning did the rest. All along the watercourses, from the Mississippi to the Potomac, the salient physical type of the caricaturists was pale, gaunt, haggard, attenuated, narrow chested, spindle-shanked, sharp featured, lantern jawed, lank-haired, anxious-eyed, with care-furrowed brow, of pasty, sallow, bilious or dyspeptic complexion, of serious concentrated, careworn expression and languid or irritable mien; his womankind, like himself, scrawny, without incentive to display the meager charms concealed by ruffles and pantalettes, and of forbidding aspect, as if about to call the police or, like the celebrated Miss Baxter who "refused a man before he axed her." The children of such parents were feeble, sickly, puling, irritable, annoying, bothersome, with the pipe stem legs noted by Henry James in "Daisy Miller" and otherwise depicted by a later novelist as "almost gnatlike." The "squash-faced" or moon-faced type of beauty, noted by the same novelist was yet to appear.[23]

Illinois *

Of the five states which form the subject of this study, Illinois was the one to be settled first, and therefore also the first to experience malaria. Illinois was originally a French settlement. The great French explorers and discoverers of the Mississippi, Joliet and Marquette, and LaSalle traversed Illinois in the 1670's and real settling seems to have started in the 1690's. The French were never very numerous; around 1750

[21] C. C. Andrews, 1856, p. 29. [22] Zeuch, 1927, p. 263. [23] Garrison, 1933, p. 163.

* A map of Illinois as well as of the other states discussed is given in order to facilitate checking of the local data. The maps are copyrighted by the Rand McNally Co. and are reproduced with the permission of the publisher.


State Population
7,897,241
County Population
is shown in thousands
with county name
City Population
100,000 and over
25,000 to 100,000
5,000 to 25,000
1,000 to 5,000
under 1,000
State Capital is shown with star-centered symbol
County Seat is shown with dot-centered symbol
Metropolitan Districts are enclosed by dashed lines
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Moline
Galesburg
Burlington
Quincy
Springfield
Peoria
Bloomington
Decatur
Danville
Champaign
Urbana
Joliet
Aurora
Elgin
Waukegan
Gary
Kankakee
Pontiac
Streator
Ottawa
La Salle
Sterling
Freeport
Clinton
Monmouth
Macomb
Canton
Pekin
Lincoln
Mattoon
Charleston
Effingham
Jacksonville
Beardstown
Carlinville
Litchfield
Centralia
Mt. Vernon
Olney
Robinson
Marshall
Paris
Vincennes
Terre Haute
Hoopeston
Watseka
Momence
Crete
Lockport
Plainfield
Oswego
Yorkville
Sandwich
Somonauk
Mendota
Earlville
Leland
Serena
Morris
Minooka
Grundy
Kendall
Will
Cook
Lake
Du Page
Kane
McHenry
Boone
Winnebago
Ogle
Lee
Whiteside
Carroll
Jo Daviess
Stephenson
Jackson
Clinton
Scott
Mercer
Henry
Bureau
Putnam
Marshall
Stark
Knox
Warren
Henderson
Hancock
McDonough
Fulton
Schuyler
Brown
Adams
Pike
Calhoun
Greene
Jersey
Macoupin
Montgomery
Shelby
Moultrie
Douglas
Edgar
Clark
Cumberland
Coles
Vermilion
Iroquois
Kankakee
Will
Grundy
Livingston
McLean
Ford
Piatt
De Witt
Logan
Mason
Tazewell
Woodford
Peoria
Knox
Warren
Henderson
Mercer
Rock Island
Louisa
Muscatine
Scott
Clinton
Jackson
Dubuque
Grant
Lafayette
Green
Rock
Walworth
Kenosha
Lake
Porter
Newton
Benton
Warren
Vermilion
Vigo
Clark
Crawford
Lawrence
Richland
Wabash
Edwards
Wayne
White
Hamilton
Franklin
Jefferson
Clay
Effingham
Fayette
Bond
Madison
St. Clair
Monroe
Randolph
Perry
Washington
Clinton
Marion
Clay
Jasper
Cumberland
Coles
Douglas
Edgar
Clark
Crawford
Lawrence
Richland
Wabash
Edwards
Wayne
White
Hamilton
Franklin
Jefferson
Clay
Effingham
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Madison
St. Clair
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Washington
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Marion
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Jasper
Cumberland
Coles
Douglas
Edgar
ILLINOIS
102 Counties
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25,496 Alexander R 14
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15,202 Boone A 18
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37,800 Bureau D 13
8,067 Calhoun K 7
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16,425 Cass I 9
70,578 Champaign H 19
30,564 Christian J 14
18,842 Clark K 21
18,947 Clay M 18
22,812 Clinton M 13
38,470 Coles J 19
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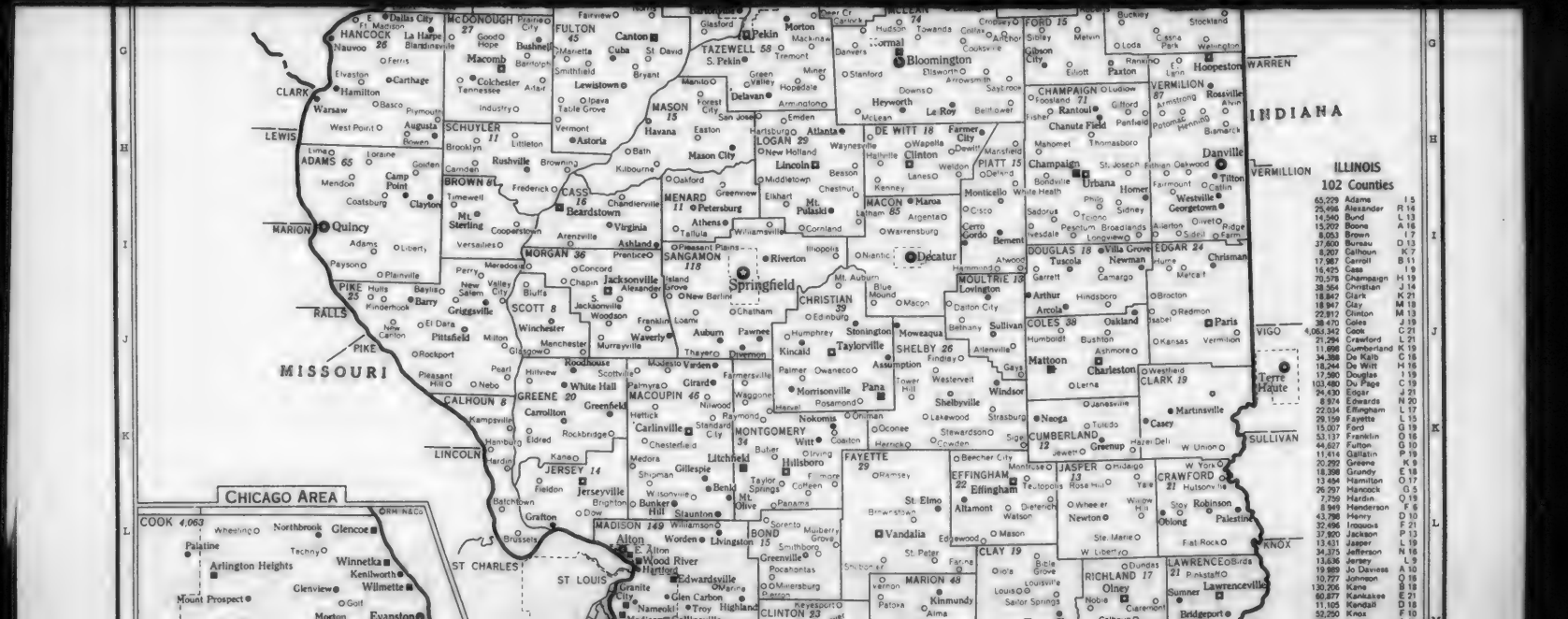
CHICAGO AREA
ILLINOIS
102 Counties
INDIANA
MISSOURI
Springfield
Decatur
Quincy
Bloomington
Danville
Terre Haute
Champaign
Urbana
Peoria
Pekin
Canton
Macomb
Jacksonville
Beardstown
Mattoon
Charleston
Effingham
Olney
Lawrenceville
Robinson
Palestine
Martinsville
Paris
Danville
Hoopeston
Watseka
Kankakee
Joliet
Aurora
Elgin
Waukegan
Chicago
Evanston
Oak Park
Cicero
Berwyn
Wheaton
Naperville
Glen Ellyn
Lombard
Elmhurst
Des Plaines
Arlington Heights
Palatine
Mount Prospect
Glenview
Wilmette
Kenilworth
Winnetka
Glencoe
Northbrook
Wheeling
Oak Lawn
Orland Park
Tinley Park
Homewood
Flossmoor
Chicago Heights
Park Forest
Blue Island
Harvey
Calumet City
Hammond
Gary
East Chicago
Whiting
Lake Michigan
Alton
Wood River
Granite City
Edwardsville
Collinsville
Belleville
Mascoutah
Highland
Troy
Nameoki
Glen Carbon
Hartford
Godfrey
Carlinville
Litchfield
Hillsboro
Taylorville
Pana
Shelbyville
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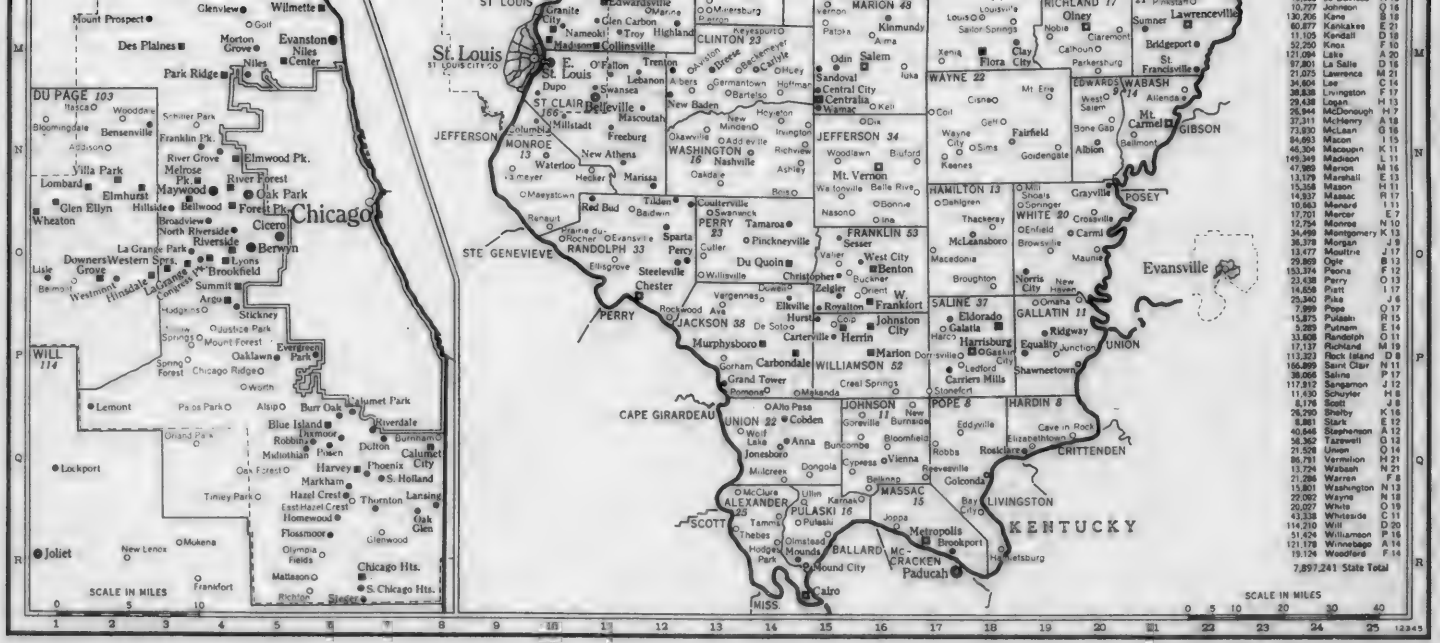
Newton
Sumner


Chicago
St. Louis
Evansville
KENTUCKY
DU PAGE 103
WILL 114
JEFFERSON
MONROE 13
ST CLAIR 166
CLINTON 23
MARION 49
WAYNE 22
EDWARDS 9
WABASH 14
WASHINGTON 16
JEFFERSON 34
HAMILTON 13
WHITE 20
GALLATIN 11
SALINE 37
FRANKLIN 53
PERRY 23
RANDOLPH 33
JACKSON 38
WILLIAMSON 52
JOHNSON 11
POPE 8
HARDIN 8
UNION 22
ALEXANDER 23
PULASKI 16
MASSAC 15
BALLARD
MC-CRACKEN
Paducah
Cairo
Metropolis
CRITTENDEN
LIVINGSTON
SCOTT
CAPE GIRARDEAU
STE GENEVIEVE
PERRY
POSEY
GIBSON
UNION
SCALE IN MILES
7,897,241 State Total

there seem to have been between 1500 and 3000 Frenchmen in the country.[24] Illinois, together with the whole of "Louisiana" on the left bank of the Mississippi, was lost to the English in 1763, and many Frenchmen left for the other, the Spanish side of the Mississippi. The influx of Americans seems to have started around 1795,[25] but it was slow, for in 1800 Illinois had only 2458 inhabitants and in 1810, 12,282. In the second decade, after the war of 1812, immigration seems to have increased, becoming greater in 1818, when Illinois obtained statehood. But in the case of Illinois malaria appears to have been a real obstacle to quick settlement, which was probably also delayed by the transport situation, later improved by the introduction of steamboats. All through the early history of Illinois the southern part was the more important and for a long time Kaskaskia was the greatest settlement. Chicago developed only after the Black Hawk War (1832) and the North was then filled with greater speed. But until the 50's when a good railroad system developed there were few settlements at any distance from rivers. Until the Civil War, Illinois was a corn producing state: after the Civil War, industry became established there. While the first settlers were predominently American born, the 1830's brought a considerable influx of Irishmen, the 1840's of Germans, the 1870's of Swedes, and later of Poles.

Data on the history of malaria in Illinois are numerous compared to other states and many of them have been already collected and analysed in the magnificent books of Zeuch and Rawlings. It would seem that more people of competent writing ability came to Illinois than to any other state and that this excellent tradition was perpetuated up to our time.

For the first 80 years of its existence as a white settlement we hear almost nothing of malaria in Illinois. Tonty, the faithful lieutenant of LaSalle, had a "fever" in 1680,[26] but even if it was malaria, he had plenty of opportunities to infect himself during his adventurous life in both hemispheres. In 1700 Father Gravier and two members of his expedition came down with tertian fever near the junction of the Ohio and Mississippi, that ill-famed region destined to gain such a notoriety for its malariousness in later years.[27] But in 1760-64 Alexander Henry was still able to write of Southern Illinois: "Mosquitoes and a minute variety of black fly abounded on this river. Sickness was unknown," [28] and there

[24] Winsor, 1884, pp. 259, 268.
[25] Drake, I, p. 641.
[26] Tonty, p. 294.
[27] Rawlings, II, p. 66.
[28] *Ibid.*, I, p. 19.

is a general consensus of opinion that during the French period the country was healthy and almost free from malaria.[29]

The change seems to have come about during the English period (1763-1776), the war and the change of government reversing the social and hygienic equilibrium, and new carriers and new non-immunes entering the country. In Morgan's diaries we read for the years of 1766-1768 the most distressing accounts of malaria epidemics at Fort Chartres and Kaskaskia. In the autumn of 1768 Morgan writes the following epilogue of the September epidemic:

> Fifty men are now fit for duty and the disorder has greatly abated. All are fairly recovered except Captain Stewart, Lieut. Turner and Patterson, the three who died after a few days of illness. About thirty men and a number of women and children were laid in their graves. Mr. Rumsey has had frequent violent attacks, Brown has had recourse to his bed almost every other day, and Hollingshead has felt the weight of the affliction.[30]

Similar reports from Colonel Croghan and Adjutant Buttrick are preserved.[31] In 1772 the Trappist monks abandoned their first location in the American Bottom because of its unhealthfulness.[32]

This situation continued during the early American period. In 1780 the garrison was again sick and starving.[33] Letters of Major Hamtranck from Fort Knox in 1789 were not more cheerful than those of Croghan and Buttrick in 1768.[34] In 1797 half of a newly arrived colony of 126 persons in Monroe County was "swept into the grave" by a "putrid and malignant fever" which did not affect the older inhabitants.[35] One of the earliest English travelers, Birkbeck, in 1800 wrote in pathetic terms of the sickliness of the inhabitants.[36] Thus by 1800 the reputation of Illinois as being unhealthy was widespread and justified. Governor John Reynolds states in his memoirs (1855): "In 1800 to 1805 the idea prevailed that Illinois was a graveyard."

Material for the occurrence of malaria during the 19th century is so plentiful that it is advisable to subdivide it into decades.

[29] Drake, I, p. 138; Rawlings, I, pp. 25, 30.
[30] Zeuch, p. 48.
[31] Zeuch, pp. 46-48; Rawlings, I, pp. 26-27.
[32] Rawlings, II, p. 435.
[33] *Ibid.*, I, p. 30.
[34] Zeuch, p. 65.
[35] *Ibid.*, p. 505.
[36] Rawlings, I, p. 30.

1810-1820

Belleville, St. Clair County, was founded in 1813 and seems to have suffered from malaria continuously for more than 100 years.[37] On Rock Island, Fort Armstrong, the first settlement, was erected in 1816. To judge from the army statistics the Fort was continuously infested with malaria from the very beginning,[38] and Rock Island itself was malarious up to the 1880's.[39] Since 1819 malaria has been recorded from White and Gallatin Counties, especially from New Haven.[40] A great body of information emanates from the English immigrants who under the leadership of George Flower and Morris Birbeck had started settling on prairie land in Illinois. One of them, Gershom Flagg, writes from Edwardsville in 1819:

The principle objection I have to this Country is its unhealthiness. The months of Aug. & Sept. are generally very sickly. I was taken sick with the fever & ague 15 Sept. which lasted me nearly two months. I shall try it one season more and if I do not have my health better than I have the season past I shall sell my property and leave the country.

And in October, 1820:

Several towns in this state have been very sickly this season, especially those situated contiguous to Rivers and Mill Ponds.

George Flower, another of these English settlers, tells of the swarms of mosquitoes and how literally everybody was stricken by the disease.[41] That the English were not the only ones to be affected is shown by the following passage from Welby:

A large party of settlers from the state of Illinois came by, they are returning to that of New York, to the same spot they quitted a year and a half ago. The account they give is that a fine fertile tract of land about forty miles from the river Illinois, and not far from its confluence with the Mississippi, was purchased by them, and they settled upon it last summer; since which period they have lost eight of their party by dysentery, fever and ague, and that the remainder had determined to quit the purchase, and return with the loss of all their time and nearly all their money.[42]

1820-1830

During the 1820's a terrible epidemic of "miasmatic" disease brought no less than 80 percent of the early settlers of Pike County into the grave.[43]

[37] *Ibid.*, II, p. 41.
[38] U. S. Army, 1840, p. 159 ff.
[39] Rawlings, II, p. 309.
[40] Zeuch, pp. 263, 265.
[41] *Ibid.*, p. 259-60.
[42] Welby, 1819, p. 211.
[43] Zeuch, p. 423; Rawlings, I, p. 35.

Mrs. Tillson gives a graphic description of ague in Pike County in 1821. Major Long's Expedition (1819-1820) observed a whole family stricken by the ague in Pope County, and the reporter Dr. James fell sick himself in Golconda.[45] The expedition of Governor L. Cass crossed Illinois in July, 1821, and Schoolcraft has much to tell of malaria in his report. The region of the Salines was apparently very malarious, the inhabitants looking pale and sickly.[46] And the inhabitants of the neighboring prairies did not look any better.[47] Along the lower Illinois again whole families were stricken as far as Fort Clark, Lake Peoria, and Schoolcraft quotes the letter of a friend from the otherwise so fertile Sangamo Valley:

> In this country, life is at least fifty per cent below par in the months of August and September. I have often thought that I ran as great a risk every season which I spend here as in an ordinary battle. I really believe it seldom happens that a greater proportion of any army falls victim to the sword during a campaign than there has of the inhabitants of Illinois to disease during a season that I have been here.[48]

The members of the expedition themselves came down with malaria at the lower Illinois.[49]

William Blane, who toured Southern Illinois in 1822, observed fevers in Palmyra and Albion, Edwards County, and found the American Bottom almost uninhabitable because of its unhealthiness.[50] James Flint reproduces accounts on excessive sickness from Vincennes and the Wabash country.[51] In Tazewell County in 1823 the babies of the early settlers died from malaria.[52] Timothy Flint had the following experience:

> The object of this excursion had been to examine into the moral condition and wants of the new settlers on the Illinois. It was taken in the month of August. I had suffered much from heat, bad food, and exposure, and had breathed the air of the Illinois, charged at this sultry season with miasma. The week after my return, I was taken down with a severe bilious fever [Flint was confined to bed for 55 days. E. A.]. Emigrants generally suffer some kind of sickness which is called "seasoning" implying that it is the summit of the gradual process of acclimation. This sickness commonly attacks them the first, second, or third year, and is generally the more severe, the longer it is delayed. This came in my third year's residence in the country.[53]

Zeuch tells of two herb doctors, Dr. Johnson of Dry Point Township

[45] James, 1823, I, p. 32; III, p. 188.
[46] Schoolcraft, 1825, p. 204.
[47] *Ibid.*, p. 208.
[48] *Ibid.*, p. 301.
[49] *Ibid.*, p. 308.
[50] Rawlings, I, p. 30.
[51] James Flint, 1822, p. 164.
[52] Zeuch, p. 524.
[53] T. Flint, 1826, p. 128.

(1827) and Dr. Rooks of Cold Spring Township (1830), Shelby County, who successfully treated "fever and ager." [54] Twyman reports of a village opposite Portage de Sioux which was abandoned because of malaria.[55]

1830-1840

The first doctor in Champaign County arriving in 1830 had to treat numerous fevers. "Miasma sought and attacked every new-comer for 25 years in the form of fevers, fever and ague and bowel complaint, and often stuck to them until they were too thin to make a shadow, and often until the shadow of death had usurped the place of their shadow." [56] But at least one 1830 foundation: Oquawka, Henderson County, was healthy for 50 years.[57] Peoria saw malaria epidemics after the Black Hawk War and again in 1838.[58] Joliet, Will County, was so sickly during the 1830's that work on the Illinois-Michigan Canal had to be stopped, one of the many cases where considerable economic loss resulted from malaria.[59] Other reports of young settlements suffering from malaria during the 30's emanate from Lee County; [60] Ashmore Township, Coles County; [61] Kankakee County; [62] Decatur, Macon County; [63] Lyndon, Whiteside County; [64] Savanna, Carroll County; [65] Putnam County; [66] and White County.[67] Blackwater fever was observed in Illinois first in 1837.[68] In the Fox River Valley, LaSalle County, and at Beaver Creek, Iroquois County, Norwegian settlers suffered terribly from malaria. The latter settlement was abandoned.[69] In 1836-37 another traveler, Edmund Flagg, expressed in eloquent terms his horror over the "fever and ague, the scourge of the West," as he observed it ascending the Illinois, in Monroe County, at Cahokia in the American Bottom.[70] It is, therefore, not surprising to hear that in 1838 the American Bottom had less population than in 1812 and numerous once flourishing villages lay in ruins.[71] A glimpse of hope is contained in the statement that after extensive drainage in 1838 the health situation in Shawneetown improved greatly.[72]

[54] Zeuch, p. 352.
[55] Twyman, p. 26.
[56] Zeuch, p. 451, 460.
[57] *Ibid.*, p. 497.
[58] Rawlings, II, p. 251.
[59] Zeuch, p. 536.
[60] Zeuch, p. 606.
[61] *Ibid.*, p. 374.
[62] *Ibid.*, p. 519; Rawlings, II, p. 199.
[63] Zeuch, p. 452.
[64] *Ibid.*, p. 603.
[65] *Ibid.*, p. 617.
[66] *Ibid.*, p. 568.
[67] Rawlings, I, p. 39.
[68] Scott, I, p. 253.
[69] Hektoen, p. 3.
[70] E. Flagg, 1838, pp. 96, 107, 127.
[71] Rawlings, I, p. 34.
[72] Drake, I, p. 317.

1840-1850

When Dr. Meldon arrived in Eldridge Village, Edgar County, around 1840, settlers still resided principally along water courses and all newcomers were subject to fever and ague.[73] In 1842 Dickens passed through Cairo and not only devoted some unpleasant remarks to it in his *American Notes*,[74] but immortalized Illinois malaria and "land promotors" in his *Martin Chuzzlewit*. From Danville, Kankakee, Darwin (Clark County) there is reported much suffering from malaria in the early 40's.[75] Dr. Nance treated much remittent and intermittent fever in Lafayette, Stark County, in 1845 and 1846;[76] Dr. Maury treated many fevers in Mercer County during the summer of 1845 but "as the season advanced the diseases seemed to assume more of a typhoid form."[77] Joliet and the Desplaines Valley which had been so malarious in the 30's and even the early 40's improved after 1847,[78] while Peoria and the surrounding prairie were still saturated with malaria in 1848.[79] The descriptive volume of Drake's great book appeared in 1850 and his data on Illinois were mostly collected in the 40's. But it would completely upset the proportions of our essay if we were only to repeat his findings in the barest outline. We have, therefore, preferred to record them on a map (fig. 1), to quote his remarks on different localities if they are of particular interest elsewhere in the text (see above concerning Jacksonville and Springfield), and to limit our use of Drake's material on malaria in Illinois in the 40's to an alphabetical list of the malarious localities he mentions, with the page number where more details can be found in the first volume of his *Systematic Treatise*: American Bottom, 137; Bloomington, 323; Cahokia, 128; Cairo, 135; Fort Chartres, 138; Meredosia, 321; Ottawa, 325; Peoria, 324; Peru, 325; Prairie du Rocher, 138; Quincy, 143; Rock Island, 145; Tazewell County, 324; West side of the Wabash, 314; Washington is listed as being free from malaria (323). Drake also mentions Chicago as being malarious (II, 106). But if Dr. Spencer in treating 140 cases of malaria in Chicago in 1849 actually treated one-third of all malaria cases in town, as it is reported, the morbidity rate of 420 in 23,000 population is not bad at all, and confirms again that malaria is predominantly a rural disease.[80]

[73] Zeuch, p. 378.
[74] Dickens, 1842, p. 183.
[75] Rawlings, II, pp. 104, 203; I, p. 39.
[76] Nance, 1853, p. 56.
[77] Maury, 1847, p. 265.
[78] Rep. Ill. Med. Soc., 1858; Rawlings, I, p. 40.
[79] Rawlings, I, p. 39.
[80] Zeuch, p. 200.

1850-1860

During the 50's remittent and intermittent fevers were still the most important health hazard in Illinois as revealed in the reports of the newly founded (1850) Illinois Medical Society. Population movements in the state because of the intense railroad building, seasonal work in the mines, etc., made for a spread of the disease from South to North. In 1854 Cook County experienced a particularly heavy epidemic and in the same year in Marshall, Clark County, every family was attacked (Report, Dr. H. R. Payne). In 1855 Vandalia and the whole Okaw River bottom were reported as being extremely malarious.[81] But elsewhere reports of improvements are increasing, e. g. from Sangamon County, after extensive drainage in 1850.[82] Quincy still suffered in the 50's, but Dr. Francis Drude in his memoirs notes a conspicuous improvement " during the last 15 or 20 years." In 1856 Dr. Gerhard published a guide for immigrants, *Illinois as It Is*, in which he tried to defend the State and to put the responsibility on the settler rather than on the country:

> Everybody knows that of all diseases the ague occurs most frequently in Illinois . . . that it depends very much upon the particular plan of abode or manner of living whether the fever is to visit a family or not. Whosoever resides in the Bottoms or close by swamps or in districts where the water cannot rapidly flow off, will be more exposed to the fever . . . One half of those who are down with fever have to ascribe this to their own imprudence . . .[83]

A more convincing argument is that he is able to quote at least three physicians for an improvement of the malaria situation in their respective districts: Dr. Daniel Stahl of Adams County, Dr. T. A. Hoffmann of Beardstown, Cass County, Dr. F. Wenzel of Belleville, St. Clair County.[83] It is interesting that among the physicians quoted by Gerhard two (Dr. J. G. Liller of Woodford County, Dr. F. Borendel of Peoria County) mention the occurrence of typhoid together with malaria and one (Dr. Stahl, Adams County) of " diarrhoea." This brings us back to our assumption, already outlined in the Introduction and illustrated with examples from the American Bottom, Kane and Stark Counties, that in the 50's malaria decreased in Illinois on a larger scale, while typhoid noticeably increased. We feel considerably enforced in this opinion by the following statement of Doctors J. S. Jewell and N. S. Davis in the 1864 report of the Illinois Medical Society:

[81] Rawlings, I, p. 40.
[82] Zeuch, p. 385.
[83] Rawlings, I, p. 41.

From 1855 to 1857 there was little of disease except malaria. After 1857 a transition from the periodic to the continued type of fever occurred. In two or three years continued fever almost entirely supplanted the autumnal type.[83]

In 1859 the highest death rate for malaria was recorded, but classification according to death causes had only begun in 1850. This is not exactly in favor of our hypothesis that the decrease of malaria in Illinois started in the 1850's. But it may be explained by the substitution of typhoid for malaria. Still more likely is that these statistics have no meaning at all. In the Introduction we have discussed the low degree of reliability of vital statistics in our field. And the Introduction of the VIIIth Census (1860) says itself (p. XXV):

It is manifest that neither in 1850 nor in 1860 was the entire mortality of any State ascertained and reported; nor was even such an approximation obtained as will permit any reliable calculation to be made of the rate of mortality, or any safe estimate of the proportion of the deaths to the living.

1860-1870

But in spite of all the hopeful signs of improvement during the last two decades malaria continued to ravage Illinois on a large scale. V. C. Vaughan states in his *Epidemiology and Public Health* that in the sixties the rural population of Southern Illinois was almost universally infected.[84] His statement is probably partly based on the impressions of his youth in Montgomery County in the summer of 1865:

In 1865 every man, woman and child in southern Illinois, at least within my range, shook with ague every other day . . . that summer I saw enough of a people held in bondage by malaria to make a lasting impression upon a boy's mind.[85]

Another medical memorialist, C. B. Johnson, who deals with Central Illinois, reports the general prevalence of malaria in Chatham in the 60's;[86] he describes a very tenacious malaria he picked up himself in 1864 in Bond County, near Greenville, and the relapses he suffered in Ann Arbor and Chicago.[87] The report of Dr. R. C. Hamill on the epidemic diseases of Illinois in the 1867 *Transactions of the American Medical Association* states:

Fevers due to miasmatic causes were of frightful frequency among the pioneers and to no inconsiderable extent still prevail in the alluvial bottoms of the rivers.[90]

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[84] Vaughan, 1923, II, p. 594.
[85] V. C. Vaughan, 1926, pp. 61, 63.
[86] C. B. Johnson, 1926, p. 96.
[87] *Ibid.*, pp. 9, 25, 32.
[90] Hamill, 1867, p. 159.

The *Reports* of the Illinois Medical Society still mention malaria repeatedly in 1860, 1867, 1869. In 1869, for example, intermittents were endemic in Champaign, Coles, Fayette, Montgomery, Kankakee Counties. In Princeton it had returned in an epidemic form after an absence of several years. In Jersey County it was but one hundredth of what it had been in the past. After 1869 malaria is mentioned but rarely in these *Reports*.[91]

1870-1900

Malaria was still widespread in Champaign County in the 70's:[92]

> Towards the close of the summer of 1872 came the last general, extensive endemic of malarial fever experienced in central Illinois. This endemic lasted from the last days of July till the coming of a killing frost and within the bounds of my practice I think almost no one escaped an attack.[93]

Dr. C. T. Reber, Shelbyville, treated 1500 cases of malaria during 18 months in 1875-1876.[94] A German traveler gives a very dreary description of the malaria situation in Cairo in 1877.[95] H. R. Carter, the famous yellow fever fighter, states that malaria just north of Cairo was still excessively prevalent in 1879, that by 1887 it was reduced to 25 percent and that in 1910 there was but little malaria left.[96] For Elgin (Kane County) malaria decline is reported since the 70's.[97] Rawlings states that malaria had begun to decline considerably before 1877, which year saw the beginning of systematic public health activity in Illinois.[98] He says of Chicago that by 1880 "it was plain that the disease [after a continuous decline since 1850, E. A.] was coming under control and would eventually disappear."[99] It is amazing to see that already in the 90's medical students from the Wabash, from Illinois River, even from Cairo, were no longer familiar enough with malaria to diagnose it.[100] Dr. C. E. Black of Jacksonville, Illinois, who is working on the documents left by the late J. F. Snyder, a busy practitioner of Virginia, Cass County (which is close to the Illinois and Sangamon Rivers!), was kind enough to inform me that among the 799 deaths recorded by Dr. Snyder between 1891 and 1921 there is not a single case of malaria. It is also significant that in 1890 the winter peak of the annual death rates becomes a striking figure.

[91] Rawlings, I, p. 40.
[92] C. B. Johnson, 1926, p. 131.
[93] *Ibid.*, p. 150.
[94] Powers and Weightman, 1876, p. 22.
[95] Hesse-Wartegg, 1881, p. 30 ff.
[96] Barber, 1930, p. 2.
[97] Rawlings, II, p. 139.
[98] Rawlings, I, p. 305.
[99] *Ibid.*, p. 113.
[100] Roskoten, 1896, p. 33.

If we try to visualize in a curve, (fig. 2) which—not being based on statistics—can be only very approximate, the resumé of all the foregoing historical records, we see malaria remain on a very low level from the first settlements up to the 1760's, then rise almost during one decade to epidemico-endemic proportions and hold this position unabated for about 70 years,—with, of course, the usual epidemic fluctuations, too subtle to be recorded here; we see it decline rather slowly in the 50's, 60's and 70's, and rapidly in the 80's so that from 1890 on, except for certain parts of southern Illinois, malaria, after having played such an important role in the history of this state, is no longer of any importance. It has virtually, if not literally, disappeared.

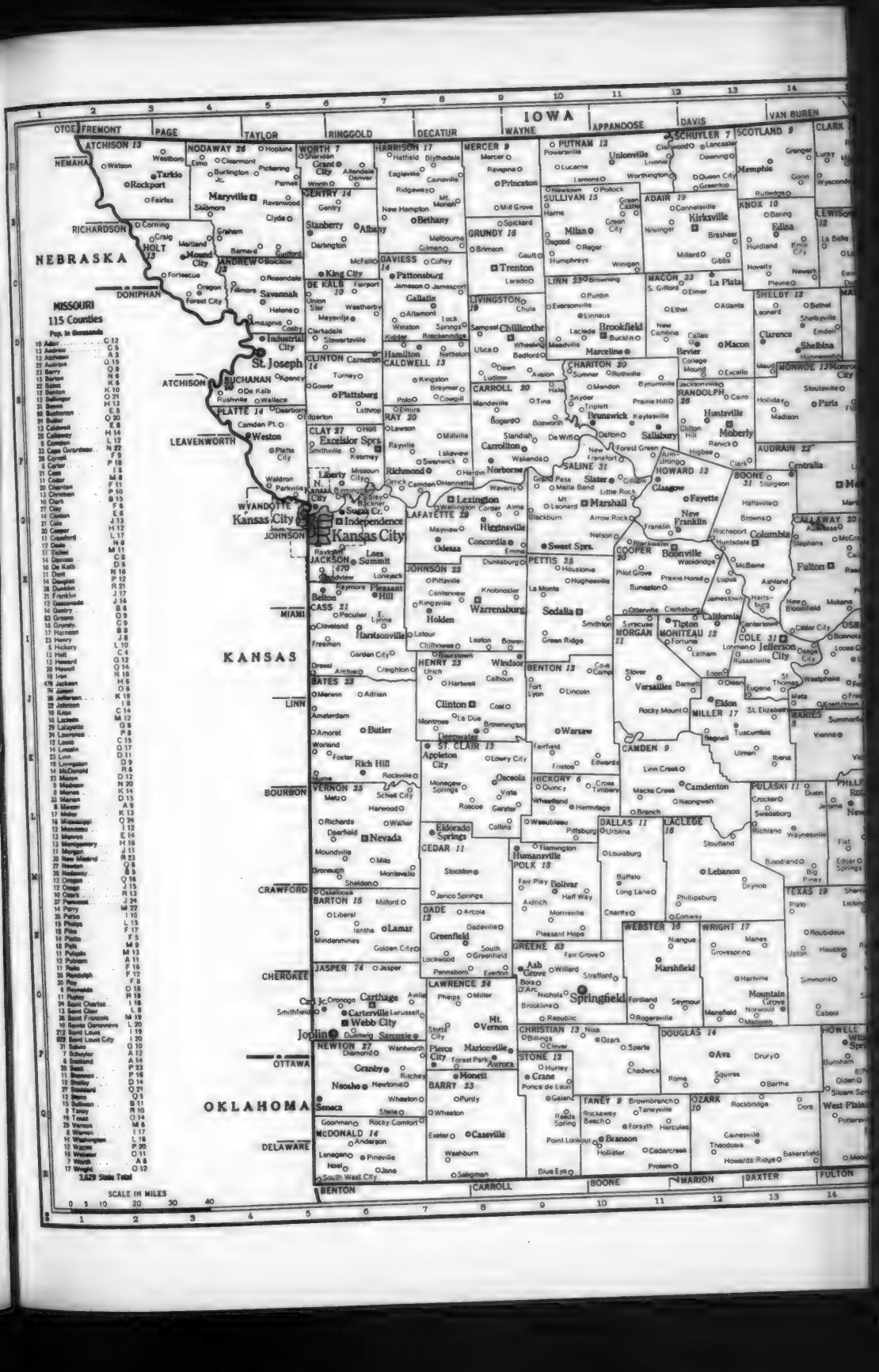
In spite of our limited confidence in the value of vital statistics for our problems we thought it seemed worth while and not without interest to trace a curve of the evolution of the malaria death rate since its first registration in 1850 (fig. 3). It reveals similar tendencies as our "free" curve. When we adopt Maxcy's criteria for "disappearance" (1 in 10,000 and less: insignificant, 1-5 in 10,000: moderate, above 5: high),[101] the point of disappearance according to mortality statistics was reached in 1900.

Missouri

Missouri also was settled by the French, at a later period and still more sparsely than Illinois. The first permanent settlement was Ste. Geneviève (founded in 1735). St. Louis was founded in 1764. After the cession to the English of the country east of the Mississippi, many Illinois Frenchmen moved over to the right bank, and in 1769 St. Louis had already 1,000 inhabitants. In the following years St. Charles, Portage de Sioux, Cape Girardeau, and New Madrid, were founded. Americans also continuously crossed the Mississippi and by 1804, when Missouri, after the Louisiana purchase of 1803 became a part of the United States, St. Louis had 10,000 inhabitants and was half French, half American. Missouri obtained statehood in 1821, and this was followed during the next decades by a rapid and massive influx of settlers. The fur trade, in addition to mining and agriculture, was an important factor in Missouri economics.

Material on malaria is much more scanty for Missouri than it is for Illinois: but this should by no means lead to the conclusion that it was less prevalent. During the French and French-Spanish periods we hear as little of malaria in Missouri as we do in Illinois. The first documents

[101] Maxcy, 1923, p. 1127.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NEBRASKA
KANSAS
OKLAHOMA
MISSOURI
115 Counties
Pop. in thousands
3,629 State Total
SCALE IN MILES
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FREMONT
PAGE
TAYLOR
RINGGOLD
DECATUR
WAYNE
APPANOOSE
DAVIS
VAN BUREN
NEMAHA
RICHARDSON
HOLT 13
ATCHISON 13
NODAWAY 26
WORTH 7
HARRISON 17
MERCER 9
PUTNAM 12
SCHUYLER 7
SCOTLAND 9
CLARK
GENTRY 14
DAVIESS 14
GRUNDY 16
SULLIVAN 15
ADAIR 19
KNOX 10
LEWIS 12
DE KALB 10
CALDWELL 13
LIVINGSTON 19
LINN 23
MACON 23
SHELBY 12
DONIPHAN
BUCHANAN
CLINTON Cameron 14
RAY 20
CARROLL 20
CHARITON 20
RANDOLPH 26
MONROE 13
PLATTE 14
CLAY 27
SALINE 31
HOWARD 13
BOONE 31
AUDRAIN 22
LEAVENWORTH
WYANDOTTE
JOHNSON
LAFAYETTE 29
PETTIS 35
COOPER 20
CALLAWAY 20
MIRIAMI
JACKSON 1,070
JOHNSON 23
CASS 21
BATES 23
HENRY 23
BENTON 12
MORGAN 11
MONITEAU 12
COLE 31
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MARIES 9
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VERNON 25
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POLK 18
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LACLEDE 16
PULASKI 11
CRAWFORD
CEDAR 11
WEBSTER 18
WRIGHT 17
TEXAS 19
CHEROKEE
BARTON 15
DADE 12
GREENE 63
JASPER 74
LAWRENCE 34
CHRISTIAN 13
DOUGLAS 14
OTTAWA
NEWTON 27
BARRY 23
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McDONALD 14
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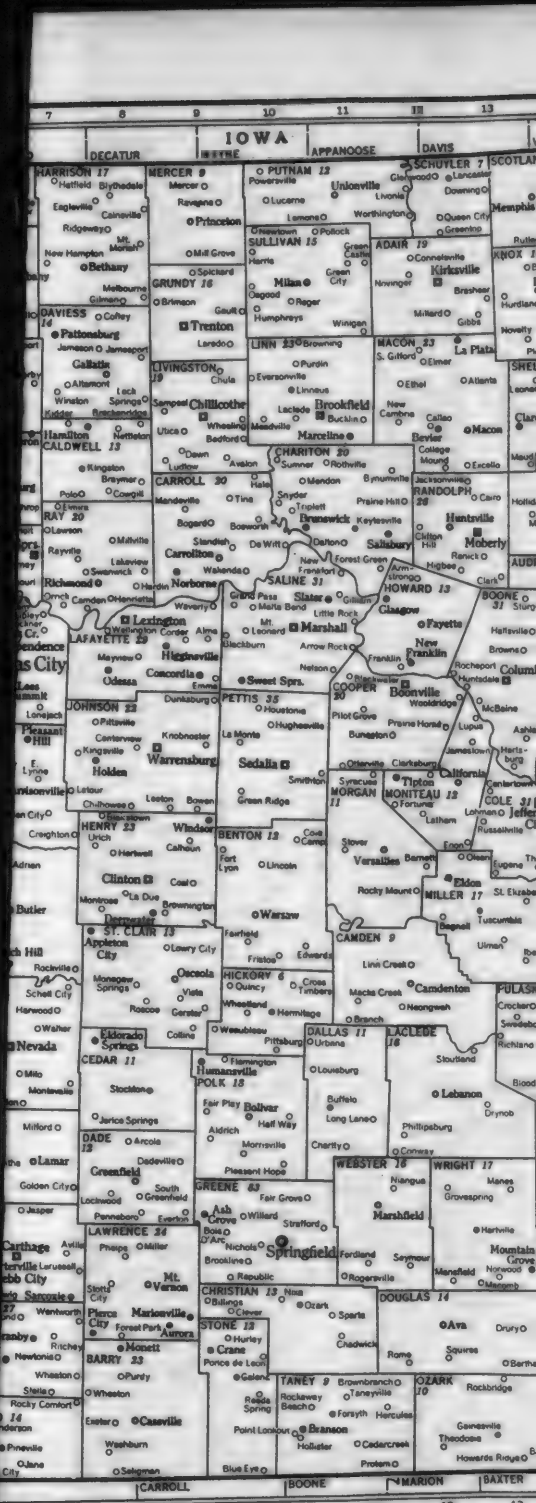
FULTON


IOWA
DECATUR
APPANOOSE
DAVIS
HARRISON 17
MERCER 9
PUTNAM 12
SCHUYLER 7
SULLIVAN 15
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MACON 23
LIVINGSTON 19
CALDWELL 13
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SALINE 31
HOWARD 13
BOONE 31
LAFAYETTE 29
COOPER 20
JOHNSON 22
PETTIS 35
MORGAN 11
MONITEAU 13
COLE 31
HENRY 23
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MILLER 17
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CAMDEN 9
HICKORY 6
CEDAR 11
DALLAS 11
LACLEDE 18
POLK 18
DADE 13
WEBSTER 16
WRIGHT 17
GREENE 63
LAWRENCE 34
CHRISTIAN 13
DOUGLAS 14
STONE 13
BARRY 23
TANEY 9
OZARK 10
CARROLL
BOONE
MARION
BAXTER

State Population
County Population
is shown in thousands
with county name
City Population
100,000 and over
25,000 to 100,000
5,000 to 25,000
1,000 to 5,000
under 1,000
ST. LOUIS AREA
SCALE IN MILES
ILLINOIS
MISSOURI
ARK.
TENN.
KY.
SOUTHEASTERN
MISSOURI
SCALE
AS MAP
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MISSOURI

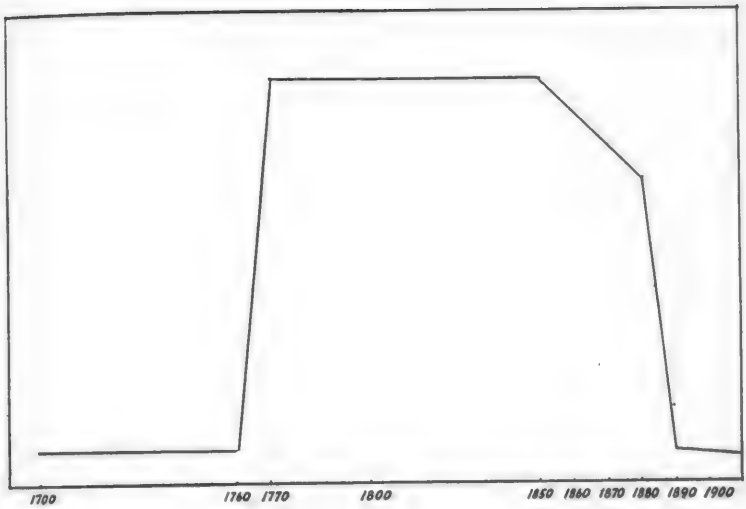


FIG. 2.

MALARIA IN ILLINOIS.

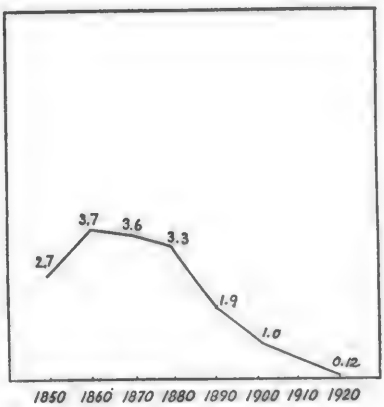


FIG. 3.

ILLINOIS.

Malaria Death Rate in 10,000 Population.

which we have seen through the courtesy of Miss M. Douglas of the Missouri Historical Society of St. Louis, are bills of Dr. A. F. Saugrain, one of the early St. Louis physicians, to P. Dorion (July 3, 1808 and March 23, 1809) where the considerable amounts of Quinia and Quinquinia prescribed leave no doubt as to the disease Monsieur Dorion suffered from. We may suppose that the same causes for the sudden increase of malaria in Illinois in the 1760's were active in Missouri between 1804 and 1819. At least for 1819 we are informed that Howard County and Savannah were very sickly from "fever" and still more so in 1820 (Contributions of Dr. Lowry in the *Missouri Intelligencer*, Franklin).[1] Long's expedition safely passed the wilderness of Missouri in 1819-1820, but the personnel all suffered very much from intermittent fever while passing on their way back through Ste. Geneviève and Cape Girardeau in October, 1820.[2] The report of the Long expedition states that settlements of the western side of the Mississippi Valley and the Missouri Valley are as sickly as on the eastern side of the Mississippi,[3] and as to the latter it had already expressed judgment in the following terms:

> The prevailing opinion in regard to this portion of the country viz. that it is unhealthy appears too well founded, to admit of refutation.[4]

Dr. McPheters reports of many cases of intermittent and remittent fever in Missouri during 1819, 1820, 1821.[5] Early settlements in Saline County (1812-1820) were abandoned because of the ague.[6] Schoolcraft noticed that malaria was very bad at St. Louis in 1821.[7] Blane observes even a decline of St. Louis in prosperty and population in 1822 because of its malariousness.[8] Settlements along the Missouri were abandoned in 1824 for this reason.[9]

Timothy Flint, the traveling missionary, paid a heavy tribute to malaria during his sojourn in Missouri. He had no less than 70 fits during one attack.[10] Two of his children and his wife fell sick.[11] The daughter of friends died from the fever.[12] He tells the story of two Kentuckians, meeting on the St. Charles Road, the one coming back from Boon's Lick, the other heading for this Mecca of the 1820 pioneer. The one who comes back says:

[1] Mullett, p. 131.
[2] James, III, p. 181.
[3] *Ibid.*, p. 212.
[4] *Ibid.*, p. 204.
[5] McPheters, 1827, p. 198 ff
[6] Hall, 1930, p. 181.
[7] Schoolcraft, 1825, p. 228.
[8] Rawlings, I, p. 30.
[9] H. C. Wright, 1851, p. 32.
[10] Flint, 1828, p. 184.
[11] *Ibid.*, p. 191.
[12] *Ibid.*, p. 190.

The people die there like rotten sheep. They have filled one graveyard already, and have begun upon another. Well go on, but I can tell you, *you will shake*![13]

For the situation during the 40's we fortunately again possess Drake's observations (see also Fig. 1). Along the Mississippi Drake notes the malariousness of the St. Francis Bottom, which sometimes has to be abandoned (I, 132), and of Jefferson Barracks, with an admission rate of 500 in 1000 (p. 138). St. Louis is better than the country opposite or in its rear (p. 141). St. Charles is " by no means exempt " from malaria (p. 142).

Malaria prevails in the bottoms of the Missouri and the Osage River every year (p. 168). Jefferson City is " subject, in a very positive degree, to autumnal fever," more infected than for instance Wheeling, Virginia (p. 168). Boonville, which has depopulated Franklin, is better than both Jefferson City and Franklin, but not so her surroundings (p. 169). Fayette and Howard County (p. 169), Miami (p. 170), Saline County (p. 170), Lexington (p. 171) and Westport (p. 171) are sickly. Arrow Rock is not greatly infected (p. 170). Fort Leavenworth has improved (p. 172). The settlements north of the Missouri are subject to annual epidemics of intermittent and remittent fevers (p. 173).

In a retrospective study published in 1847 Dr. L. Twyman reports that between 1829 and 1841 the inhabitants of St. Charles County suffered from intermittent and bilious fevers quite regularly every year from August to October.[14]

The *Transactions* of the A. M. A. of 1855 contain a voluminous report on the diseases of Missouri by Dr. T. Reyburn for the years 1851-1854.[15] Although Reyburn mostly deals with St. Louis (" the diseases of the chief commercial city are the diseases of the State "), although he draws heavily upon Drake, and although he deals more with such dramatic epidemics as cholera, black tongue, etc., he has also much to say on malaria.

The most prevalent fevers to which the adult is subject in our climate, are those known under the title of bilious fever, bilious remittent fever, intermittent fever and congestive fever. It is these that constitute a large proportion of the physician's business in the summer and autumn months (p. 114).

On the typhoid-malaria problem Reyburn makes the following remarks:

Continued fever, as recognized in the term typhoid, is of recent origin in our district, its recognition previous to the past twelve or fourteen years being seldom

[13] *Ibid.*, p. 207.
[14] Twyman, 1847, p. 27.
[15] Reyburn, 1855, pp. 88-323.

admitted. As seen in our district, typhoid fever, or the fever to which we have reference under such title, in its inception resembles ordinary bilious fever (p. 106).

In this section of the West typhoid fever prevails in this part of the country and is annually increasing, superseding to some degree our endemic bilious fevers (p. 110).

Reyburn's informant, Dr. Napee, writes him in 1851 from Gasconade County:

Intermittent fever is endemial in this as in all other sections of the State, but in this year, it was unusually prevalent, obstinate and much disposed to relapse (p. 129).

Prevalence of intermittents and remittents is reported from Ste. Geneviève, from Chariton County, Andrew County, Marion County (in the bottoms) and De Kalb County, where their ready yielding to quinine is emphasized. Malarious diseases prevail also in Buchanan County, but "their diminution is apparent with the progress of improvement, drainage, and tillage of the land" (p. 139). In 1852 Buchanan County had its first typhoid epidemic.

The first volume of the *Transactions* of the Missouri State Medical Association (1850) equally notes the general prevalence of malaria, and the occurrence of typhoid fever. In 1856 Dr. Knode published the following interesting observation:

Yet locality does not seem to predispose to malarious disease. In many places in the large wooded bottoms along the Missouri River where lakes and ponds of stagnant water abound with immense growths of vegetable matter undergoing decomposition, the people are sometimes much more exempt than those who reside in the high open prairie.[16]

In 1866 malaria was widespread in Kansas City.[17] Barber states:

In the wooded country of Western Missouri in the valley of the Missouri River malaria was plentiful during the late sixties and early seventies. Nearly everybody along the river bottoms suffered from it, but the hill country was spared . . . Malaria began to diminish in a marked degree in the late seventies.[18]

In the 70's Palmyra, situated at 7 miles distance from the Mississippi, had but little malaria.[19] From August to November 1875 the St. Louis City Dispensary treated 788 cases,[20] this in spite of the fact that the St. Louis death rate had diminished from 58.5 per 1,000 to 21.5 and 20.1 in 1870 and 1880.[21]

[16] Knode, 1856, p. 411.
[17] Goldstein, 1900, p. 104.
[18] Barber, 1930, p. 8.
[19] Pryor, 1943, p. 68.
[20] Powers and Weightman, 1876, p. 15.
[21] Ellis, 1930, p. 172.

In 1872 there was still much malaria in Kansas City.[21] Hackett quotes a physician as being impressed by the fact that in the 80's in Southwestern Missouri there would be a light in almost every home after midnight showing the presence of a case of malaria. Nevertheless malaria was less intense in those regions than e. g. Macedonia.[22] St. Charles was still malarious in 1900.[23]

The *Transactions* of the Medical Society of 1886 contain a valuable report of Dr. Hart on malaria fever. 37 counties have answered his queries. 28 report a decline during the last year, 7 an unchanged situation, 2 increase. Intermittents prevail in 23 counties. Only few hematuric cases are seen. During the last years a gradual decline seems to have taken place in 34 counties, increase only in 3. The remittents usually last 10-12 days, the "typho-malarial" fevers from 3 to 6 weeks. The latter do not yield to quinine.

Reports of the State Board of Health have been published since 1884. During 17 years they do not deal with malaria. That this is no proof of its absence is shown by the Report of the State Board of Health for 1901 in Extracts from its correspondence (p. 46 ff.) giving the following data:

Bollinger County:	almost free from malaria
Butler County:	little malaria during this year because of the dry summer
Carroll County:	malaria and typhoid prevailing
Cass County:	malaria sporadic; still very malarious
Clay County:	malaria rapidly on the decrease
DeKalb County:	less malaria; still very malarious
Lawrence County:	less malaria
Madison County:	a few cases of malaria
Marion County:	considerable malaria
Mississippi County:	certain parts malarious
Oregon County:	little malaria (used to be prevalent)
Polk County:	little malaria
Pulaski County:	less malaria
St. Clair County	not much malaria left after drainage
Scott County:	malaria reduced
Wright County:	little malaria this year; generally most prevalent

This cross section throws a sudden light on the malaria situation, as it still was in 1900 in Missouri. For those who are not familiar with the geography of the state, it may be emphasized that only three of the mentioned counties (Butler, Mississippi, Scott) belong to the notorious Southeast corner, which is still endemic (see Introduction). Ten, that is the majority, have a positively Northern or Northwestern location.

[21] Hackett, 1937, p. 239.

[22] Goldstein, 1900, p. 51.

Although for the reasons presented in the Introduction we do not wish to overdo the importance of statistics in general and particularly the statistics of army posts, the trends of morbidity statistics in Jefferson Barracks should not be left unmentioned. The average morbidity rate for intermittent and remittent fever between 1829 and 1838 is about 500 in

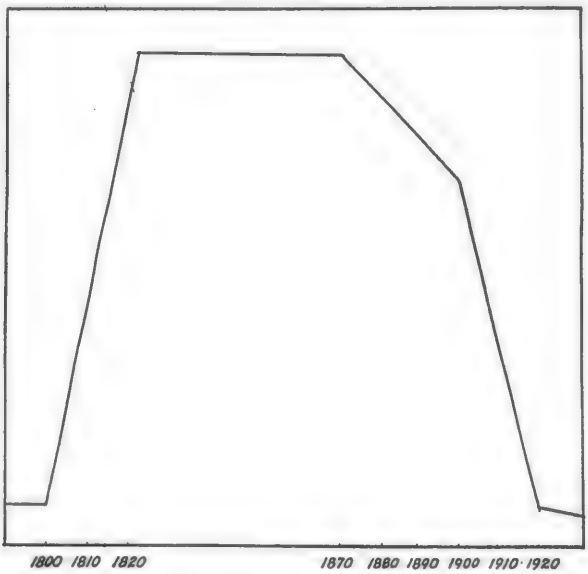


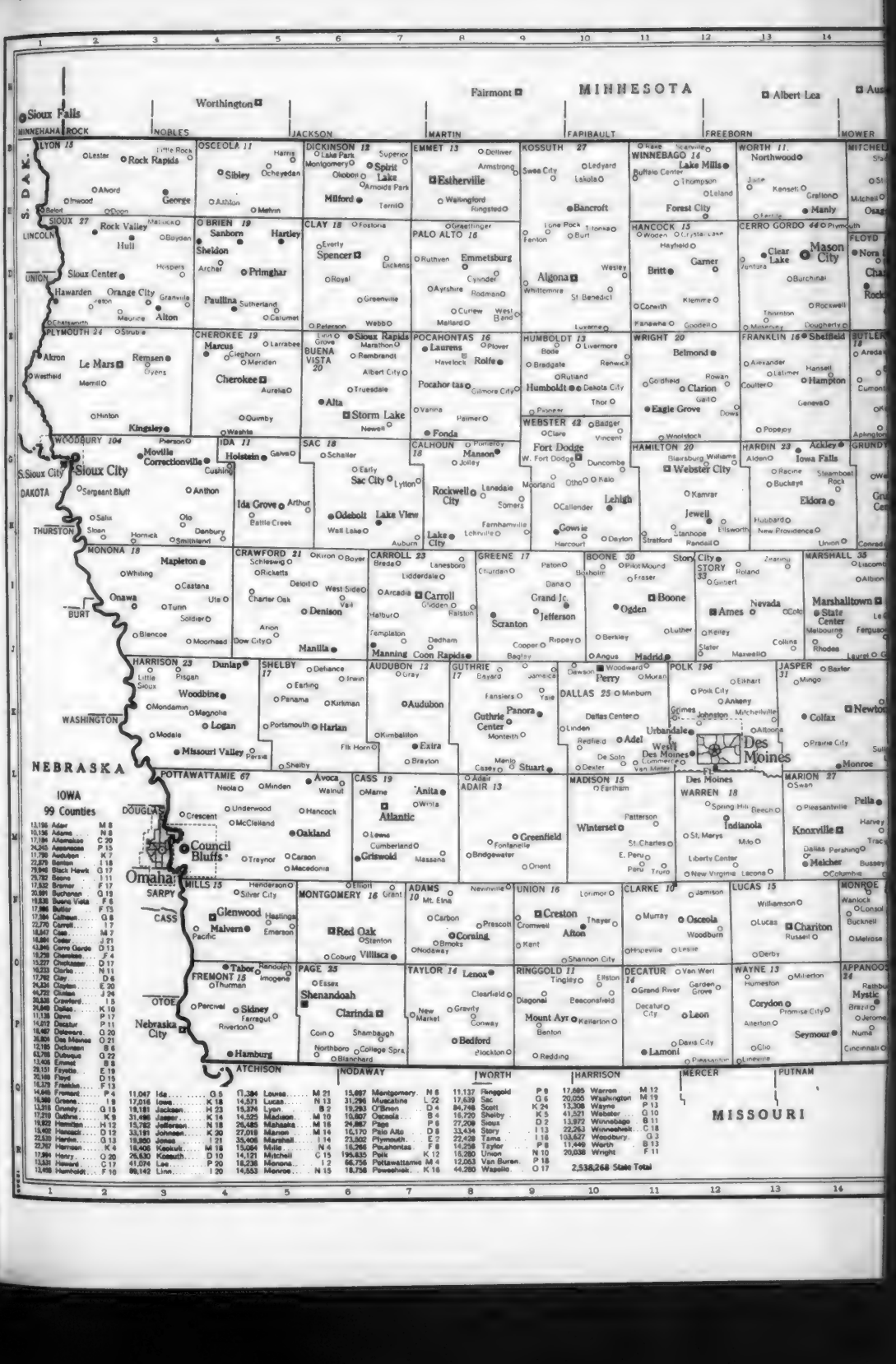
FIG. 4.

MALARIA IN MISSOURI.

1000 men.[24] From 1878 to 1886 the admission rate oscillates around 900 in 1000. In 1889 the curve descends for the first time to a morbidity of less than 300 in 1000, not to reach above this level after 1897. Since 1906 the decline is more rapid and regular, reaching the low point of 5 in 1000 in 1924.[25]

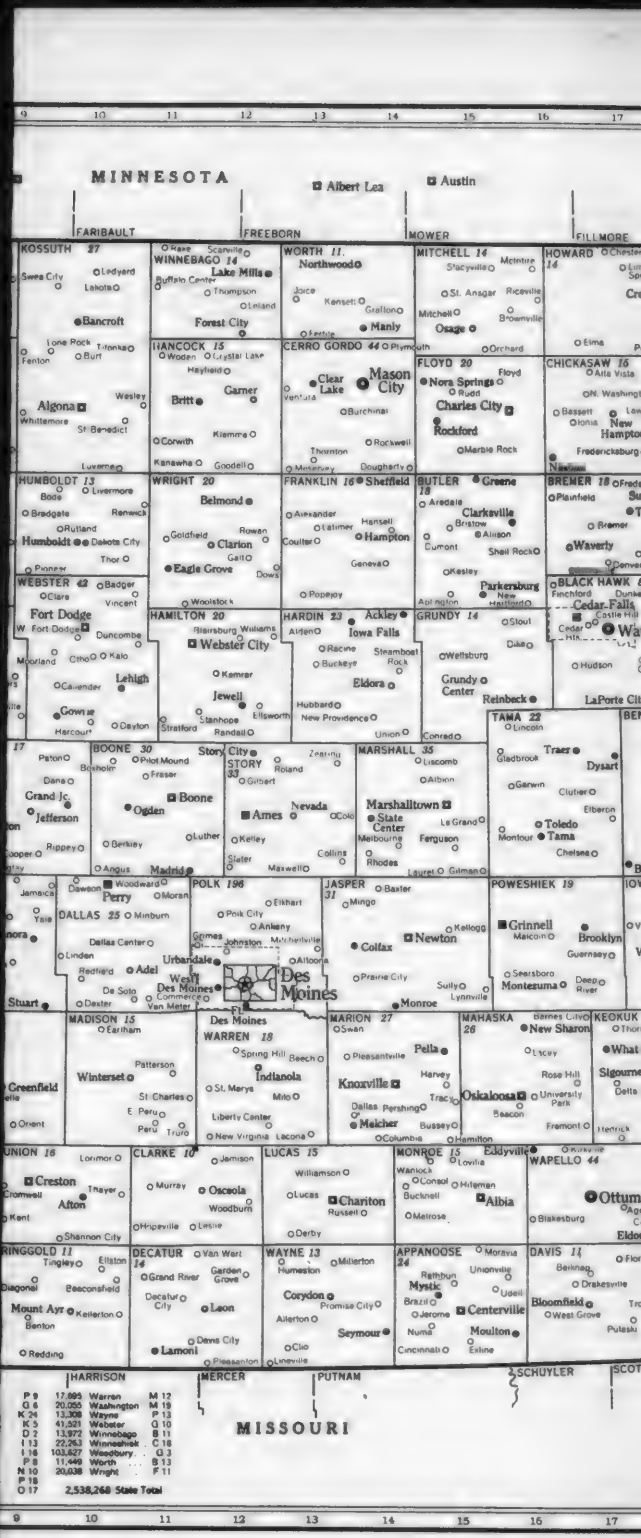
Again summarizing our information in the form of a graph (Fig. 4), we must admit that we do not know the date of the initial increase of malaria in Missouri but that we may safely place it between 1805 and 1815. At any rate in 1820 a high endemic-epidemic level is reached and seems to be maintained, with the usual epidemic fluctuation, for 50 years up to the

[24] U. S. Army, 1840, pp. 216 ff. [25] Love, 1926, p. 29.



13,196	Adair	M 8	11,047	Ida	G 5	11,384	Louisa	M 21	15,697	Montgomery	N 8
10,156	Adams	N 8	17,016	Iowa	K 18	14,573	Lucas	N 13	31,756	Muscatine	L 22
17,184	Allamakee	C 20	18,181	Jackson	H 23	15,374	Lyon	B 2	19,293	O'Brien	D 4
24,245	Appanoose	P 15	31,496	Jasper	K 14	14,525	Madison	M 10	10,807	Osceola	B 4
11,780	Audubon	K 7	15,782	Jefferson	N 18	26,485	Mahaska	M 16	24,887	Page	P 6
22,879	Benton	J 18	33,181	Johnson	K 20	27,019	Marion	M 14	16,170	Palo Alto	D 8
18,847	Black Hawk	G 17	19,850	Jones	J 21	35,406	Marshall	I 14	21,502	Plymouth	E 2
29,782	Boone	I 11	18,408	Keokuk	M 18	15,084	Mills	N 4	16,266	Pocahontas	F 8
17,532	Bremer	F 17	26,630	Kossuth	D 10	14,121	Mitchell	C 15	195,835	Polk	K 12
20,997	Buchanan	G 19	41,074	Lee	P 20	18,236	Monona	I 2	66,756	Pottawattamie	M 4
18,838	Buena Vista	F 6	99,142	Linn	I 20	14,553	Monroe	N 15	18,758	Poweshiek	K 16
17,986	Butler	F 13									
17,369	Calhoun	G 8									
22,770	Carroll	I 7									
18,847	Cass	M 7									
18,081	Cedar	J 21									
43,845	Cerro Gordo	D 13									
18,259	Cherokee	F 4									
15,227	Chickasaw	D 17									
10,233	Clarke	N 11									
17,782	Clay	D 6									
24,334	Clayton	E 20									
44,721	Clinton	J 24									
30,830	Crawford	I 5									
19,922	Dallas	K 10									
11,136	Davis	P 17									
16,012	Decatur	P 11									
18,497	Delaware	O 19									
36,804	Des Moines	O 21									
12,185	Dickinson	B 6									
63,798	Dubuque	D 22									
13,406	Emmet	B 8									
20,151	Fayette	E 19									
20,148	Floyd	D 15									
16,379	Franklin	F 13									
14,646	Fremont	P 4									
18,380	Greene	I 9									
13,518	Grundy	G 15									
17,210	Guthrie	K 9									
18,822	Hamilton	H 12									
15,400	Hancock	D 12									
22,533	Hardin	G 13									
22,767	Harrison	K 4									
17,394	Henry	O 20									
13,531	Howard	C 17									
13,498	Humboldt	F 10									

11,137	Ringgold	P 9	17,685	Warren	M 12						
17,639	Sac	G 6	20,056	Washington	M 19						
84,748	Scott	K 24	13,308	Wayne	P 13						
16,720	Shelby	K 5	41,501	Webster	G 10						
27,209	Sioux	D 2	13,972	Winnebago	B 11						
33,434	Story	I 13	22,263	Winneshiek	C 18						
22,428	Tama	I 16	103,627	Woodbury	G 2						
14,258	Taylor	P 8	11,449	Worth	B 13						
16,280	Union	N 10	20,038	Wright	F 11						
12,063	Van Buren	O 18									
44,260	Wapello	O 17	2,538,268	State Total							


MINNESOTA
Albert Lea
Austin
FARIBAULT
FREEBORN
MOWER
FILLMORE
KOSSUTH 27
WINNEBAGO 14
Lake Mills
Forest City
WORTH 11
Northwood
MITCHELL 14
HOWARD 14
HANCOCK 15
Britt
Garner
CERRO GORDO 44
Clear Lake
Mason City
FLOYD 20
Nora Springs
Charles City
Rockford
CHICKASAW 15
Fredericksburg
HUMBOLDT 13
Humboldt
Dakota City
WRIGHT 20
Belmond
Clarion
Eagle Grove
FRANKLIN 16
Sheffield
Hampton
BUTLER 18
Greene
Clarksville
Parkersburg
BREMER 18
Plainfield
Waverly
WEBSTER 42
Fort Dodge
HAMILTON 20
Webster City
Jewell
HARDIN 23
Ackley
Iowa Falls
Eldora
GRUNDY 14
Grundy Center
Reinbeck
BLACK HAWK
Cedar Falls
LaPorte City
TAMA 22
Toledo
Tama
BOONE 30
Boone
Ogden
STORY 33
Ames
Nevada
MARSHALL 35
Marshalltown
State Center
POWESHIEK 19
Grinnell
Montezuma
DALLAS 25
Perry
Adel
Urbandale
Des Moines
POLK 196
JASPER 31
Newton
Colfax
MADISON 15
Winterset
WARREN 18
Indianola
MARION 27
Pella
Knoxville
MAHASKA 26
Oskaloosa
KEOKUK
UNION 16
Creston
CLARKE 10
Osceola
LUCAS 15
Chariton
MONROE 15
Albia
WAPELLO 44
Ottumwa
RINGGOLD 11
Mount Ayr
DECATUR
Leon
Lamoni
WAYNE 13
Corydon
APPANOOSE
Mystic
Centerville
DAVIS 11
Bloomfield
HARRISON
MERCER
PUTNAM
SCHUYLER
MISSOURI
P 9 17,895 Warren M 12
G 6 20,055 Washington M 19
K 24 13,308 Wayne P 13
K 5 41,521 Webster Q 10
D 2 13,972 Winnebago B 11
I 13 22,263 Winneshiek C 16
I 18 103,627 Woodbury Q 3
P 8 11,449 Worth B 13
N 10 20,038 Wright F 11
P 18
O 17 2,538,268 State Total

DES MOINES AREA
BOONE 30
Madrid
Slater
Huxley
STORY 33
DALLAS 28
POLK 196
Alleman
Elkhart
Polk City
Granger
Herrold
Ankeny
Bondurant
Grimes
Saylorville
Johnston
Saylor
Norwoodville
Altoona
Urbandale
Clover Hills
Des Moines
West Des Moines
Commerce
Fort Des Moines
Levey
WARREN 18
Carlisle
Cumming
SCALE IN MILES
HOUSTON
VERNON
WINNESHIEK 22
Burr Oak
Highlandville
Decorah
Ridgeway
ALLAMAKEE 17
New Albin
Lansing
Waukon
Waterville
Rossville
Harpers Ferry
Postville
CLAYTON 24
Monona
Marquette
McGregor
CRAWFORD
FAYETTE 29
Waucoma
Clermont
Elgin
West Union
Hawkeye
Fayette
Wadena
Maynard
Westgate
Arlington
Oelwein
Farmersburg
St Olaf
Read
Clayton
Garnavillo
Elkader
Volga City
Littleport
Guttenberg
WISCONSIN
GRANT
Strawberry Point
Edgewood
N. Buena Vista
BUCHANAN 21
Fairbank
Hazleton
Aurora
Lamont
Winthrop
Independence
Jesup
Oussqueton
Rowley
Brandon
DELAWARE 18
Greeley
Colesburg
Manchester
Earlville
Delhi
Ryan
Hopkinton
DUBUQUE 64
Sherrill
New Vienna
Dyersville
Dubuque
JO DAVIESS
Farley
Epworth
Worthington
Massey
Cascade
Zwingle
La Motte
Bellevue
JACKSON 19
Canton
Andrew
Monmouth
Sabula
Baldwin
Maquoketa
Preston
CARROLL
WHITESIDE
CLINTON 45
Delmar
Andover
Lost Nation
Charlotte
Welton
Calamus
Grand Mound
Wheatland
Dewitt
Clinton
Camanche
Dixon
SCOTT 85
Eldridge
Princeton
Walcott
Pleasant Valley
LeClaire
ROCK ISLAND
Buffalo
Davenport
Bettendorf
Moline
Rock Island
ILL.
MUSCATINE 31
Nichols
Muscatine
Montpelier
Conesville
Waterloo
Gilbertville
Porte City
BENTON 23
Mt. Auburn
Urbana
Vinton
Garrison
Shellsburg
Van Horne
Newhall
Keystone
Albion
Blairstown
Norway
Belle Plaine
LINN 89
Walker
Coggon
Center Point
Central City
Robins
Palo
Springville
Marion
Mt. Vernon
Cedar Rapids
Ely
Alburnett
JONES 20
Monticello
Stone City
Center Jc.
Onslow
Anamosa
Wyoming
Martelle
Olin
Morley
Oxford Jc.
CEDAR 17
Mechanicsville
Clarence
Stanwood
Lowden
Tipton
Bennett
West Br.
Downey
Durant
Atalissa
Wilton
Moscow
West Liberty
Hills
IOWA 17
Marengo
Amana
Ladora
Homestead
Victor
Williamsburg
Parnell
Millersburg
JOHNSON 33
Solon
N. Liberty
Oxford
Tiffin
Coralville
Iowa City
KEOKUK 18
Thornburg
South English
Keswick
What Cheer
Sigourney
Keota
Harper
Delta
Hedrick
Ollie
Richland
WASHINGTON 20
Riverside
Lone Tree
Wellman
Kalona
Washington
Ainsworth
Crawfordsville
Brighton
Westchester
Haskins
LOUISA 11
Letts
Fredonia
Grandview
Columbus Jc.
Columbus City
Wapello
MERCER
Winfield
Morning Sun
Oakville
JEFFERSON 16
Pleasant Plain
Packwood
Ottumwa
Agency City
Eldon
Batavia
Fairfield
Libertyville
HENRY 18
Mt Union
Mt. Pleasant
New London
Salem
Hillsboro
DES MOINES 37
Yarmouth
Mediapolis
Danville
West Burlington
Burlington
HEN-DERSON
VAN BUREN 13
Birmingham
Stockport
Keosauqua
Bonaparte
Milton
Farmington
Mt. Sterling
Donnellson
LEE 41
Houghton
St. Paul
West Pt
Denmark
Ft. Madison
HANCOCK
SCOTLAND
CLARK
Montrose
County House
Mooar
Keokuk
ILL.
State Population
2,538,268
County Population
is shown in thousands
with county name
City Population
100,000 and over
25,000 to 100,000
5,000 to 25,000
1,000 to 5,000
under 1,000
State Capital is shown with star-centered symbol
County Seat is shown with dot-centered symbol
Metropolitan Districts are enclosed by dashed lines
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SCALE IN MILES
0 5 10 20 30 40
17 18 19 20 21 22 23 24 25
A B C D E F G H I J K L M N O P Q R

IOWA

70's when a slow decrease starts; the decrease speeds up during the first decade of this century, to reach the " disappearance " level only between 1910 and 1920, except for the Southeastern counties dealt with in the Introduction. We attach (Fig. 5) a graph representing the malaria death rates of the census from 1850 to 1920, without feeling able to use them for a detailed analysis of the process of malaria decline.

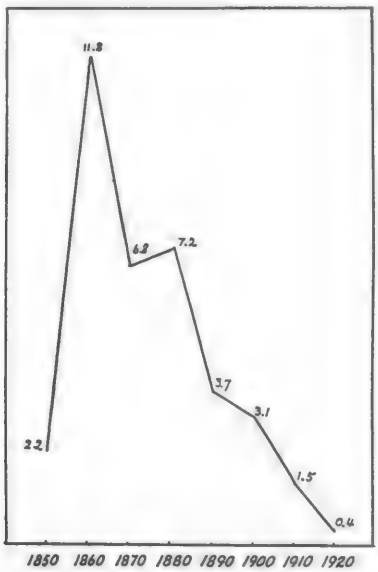

FIG. 5.

MISSOURI.

Malaria Death Rate in 10,000 Population.

IOWA

French and American explorers and trappers, Joliet and Marquette, Lewis and Clark passed through Iowa. But in spite of the fact that Dubuque obtained his grant of land in 1788, Iowa was an Indian country up to the 1830's and only then, especially when the victory over Black Hawk in 1832 had removed the Indian menace, can white settlements in Iowa be seriously considered. Thereafter the country was then settled with great speed, and in 1846 Iowa became a state. It experienced apparently

the greatest rush of settlers in the 50's, when also the first railroad was built. Iowa is still an agricultural state; but its agriculture underwent important changes with which we will have to deal later.

It would be preposterous to claim as some books do at second hand that Sergeant Charles Floyd of the Lewis and Clark expedition, who died in 1804 in Iowa from an acute disease, was the first victim of malaria in Iowa. Perusal of the original sources shows that Floyd died within 24 hours of "bilious chorlick" which may have been almost any acute abdominal disease.[1]

In 1839 Plumber in his famous *Sketches of Iowa and Wisconsin*, destined to guide immigrants, declares that "in 1838 there were no fevers in Iowa and Wisconsin."[2] "No case of fever and ague has ever originated in the country."[3] His example shows with what caution contemporary literature has to be used, especially when the author represents "vested interests." He is himself obliged to admit in another passage of his "guide":

> The general health of the country is good. Immediately on the river [but all settlements in Iowa at that time were on some river. E. A.] some sickness has prevailed to some extent, and it must be confessed that at two or three of the towns it must ever be unhealthy.[4]

The truth seems to have been far more dramatic. As soon as the rapid settling of the state started, malaria seems to have broken loose everywhere. Prof. W. J. Petersen tells us: "Fever and ague shook the frontier in 1838." He speaks of the appalling number of deaths in Burlington, and has saved from oblivion the precious little description—already quoted in the Introduction—of the shaking children near Burlington: a document which contains the whole malaria problem in a nutshell (settlements along watercourses, transport on board ships, New England free from malaria, infantile malaria, etc.).[5] Black Hawk, the great Indian gentleman, seems to have himself died in 1839 from malaria. And in the same year a Mr. Deweber wrote a letter to Dr. Sappington, offering his services as an agent for the famous Sappington Fever Pills in Bloomington and surroundings, where the article was badly needed.[6] The *Iowa Journal of History* published in 1938 the diaries of a certain Cyrus Sanders who settled in 1839

[1] Allen, 1814, I, p. 48.
[2] Plumber, 1839, p. 484.
[3] *Ibid.*, p. 518.
[4] *Ibid.*, p. 515.
[5] W. J. Petersen, Doctors, 1938, pp. 401, 402.
[6] Archives State Historical Society of Missouri, Columbia, Mo.

in Johnson County. Sanders describes dryly and conscientiously, but unfortunately with too much detail to reproduce here, the attacks of bilious fever he suffered in his new home during 1839 and 1840. It is one of the most graphic and appalling descriptions of the malaria sufferings of a lonely pioneer I have ever read.[7]

For the 40's Drake informs us that Iowa, south of the Des Moines, was malarious but less so than Missouri, thanks to its more northern location.[8] On the subject of autumnal fever in Burlington he quotes Dr. Henry:

> The bottom lands above and below the city are the chosen seats of intermittents, by which the people every year are more or less prostrated, nor do the immigrants seem to become acclimated. Remittents also occur. It is an undecided point whether the people of the city site on the bottom are more subject to fever than those on the bluff. The country population in the rear of the city are not exempt from the fever.[9]

Ague troubled the Norwegians who settled in Mitchell County in 1853. The Norwegian colony at Lansing suffered much from malaria in 1846.[10] According to Cole, one of the few state historians in the Upper Mississippi Valley to mention malaria (!), the wet years of 1849-1851 in Iowa were followed by terrible epidemics of malaria.[11]

For the malaria situation in Iowa during the late 40's and early 50's we have excellent source material in the article of Dr. J. F. Henry in the *Western Medico-Chirurgical Journal* (1851, pp. 298-307): "Medical Topography, Climate and Diseases of Iowa." As this Journal has become a rarity we feel entitled to quote Dr. Henry rather extensively.

Dr. Henry says of the river bottoms where the majority of settlements still were to be found at that time:

> They are very fertile; they are very damp from river influences . . . As a consequence they are exceedingly destructive to health and human life. The inhabitants no matter from what region they come, soon become subjects of some form of what, for want of a more comprehensive and precise term is called bilious disease, and unless they fly from their homes, they are again and again attacked, until the constitution is broken down, and some organic disease supervening, they sooner or later sink into the grave the victims of malaria. But this may be protracted for many years, the patient becoming listless, sluggish, good-for-nothing, and carrying with him visceral enlargements of great size. In one case, that of a thin, tall female, I found an enlarged spleen reaching from beneath the ribs to the pubes—a distance in her case of more than 12 inches. These dwellers on the bottoms must be a short lived race, nor are they a prosperous one; owing to repeated

[7] Sanders, 1938, pp. 71 ff.
[8] Drake, I, p. 173.
[9] Drake, I, p. 144.
[10] Hektoen, p. 10.
[11] Cole, 1940, p. 211.

sicknesses they tend their crops badly, and thus from year to year they fall behind their neighbours on the uplands. They live in cabins daubed with mud, with wooden chimneys, and no glass in their windows. They lack energy to burn lime-kilns, although the rock may be quite accessible in some neighbouring bluff. It makes but little difference whether the bottom is prairie or timberland. The essential elements and the results are similar in either case. Let no immigrant settle on bottom land. (P. 300).

Of the river towns Henry has the following to say:

Our principal river towns may form a distinct class. Their first settlement was followed by seasons of sickness, often to all inhabitants, sometimes none escaping. This was owing to the usual prevalence of malaria from stagnant water and drainage, aggravated badly by badly built houses and by poor living. So far as I am informed our river towns are uniformly and rapidly improving in their healthful conditions [better drainage, houses, living] (p. 303).

And this Dr. Henry has to say on the healthiest category—prairie lands:

Prairie lands are by universal consent admitted to be as healthful as any new country ever was. An extensive and simultaneous breaking up of prairie rarely fails to generate bilious disease, but in a year or two all decaying roots, etc., having commingled with the earth, all is right again (p. 302).

Dr. Henry states that the Des Moines Valley is very unhealthful from autumnal fevers (p. 302) and afflicted with more severe forms than those observed north of the Iowa River (p. 305).

Dr. A. J. Field of Des Moines in his "The Medical Aspects of Iowa" (*Chicago Medical Journal* XXIV, pp. 114 ff.) writes in 1867, that is 16 years after Henry:

Families living near recent breaking [of prairie], during a summer or autumn, seldom escape malarious disease (p. 119).

Families in bottom lands seldom escape malarious disease (p. 120).

The *Transactions* of the American Medical Association of 1874 contain a report of Dr. J. J. M. Angear of Green Bay township, Lee County. He complains that there are no public records in Iowa, but "there are so many places we know are healthier than formerly." In so far as his own location is concerned there was "some years ago a great deal of sickness of a malarious type" but throwing up a levee, digging a ditch, grazing cattle have made it now as little malarious as "high clayey land." [12] Dr. Blake reports Warren County as being malarious in 1874.[13] Dr. J. W. Fink describes a malaria epidemic in Hillsborough in 1874.[14] He tells that Montgomery County had its normal decline in malaria up to 1870; but

[12] Angear, 1874, p. 395. [13] Blake, 1874, p. 124. [14] Fink, 1876, p. 124.

then for unknown reasons the disease increased again (the "malaria" he deals with was yielding to quinine and is therefore unlikely to have been typhoid.)[15]

The Iowa State Board of Health was founded in 1880. Its first biennial reports give, under the reading "Special correspondence," somewhat hidden but quite valuable information on the occurrence of malaria in Iowa during the 80's. "Special correspondence" contains actually the answers of physicians from all parts of the State concerning the diseases of Iowa. From the first *Biennial Report* covering 1880 and 1881 (published in Des Moines, 1882) we take the following facts:

Northeast Division:	
Clermont, Fayette County:	intermittents from April to October (p. 80)
Postville, Allamakee County:	intermittents in April and November-December (p. 82)
Strawberry Pt., Clayton County:	less malarial deaths than in foregoing years (p. 85)
Manchester, Delaware County:	malarial fever from May to October (p. 87)
Eastern Division:	
Mount Auburn, Benton County:	malarial fevers in May and September (p. 94)
Lowden, Cedar County:	remittent and intermittent fever from May to August (p. 96)
Mechanicsville, Cedar County:	intermittent fever May-July (p. 97)
Southeastern Division:	
Mediapolis, DesMoines County:	intermittents and remittents May-August (p. 107)
Northern Division:	no mention of malaria
Southern Division:	
Unionville, Appanoose County:	malarial fevers June-August (p. 120)
Blakesburg, Wapello County:	intermitting and remitting fever March, April, July-Sept. (p. 127)
Northwestern Division:	
Newell, Buena Vista County:	remittent and typhomalarial in October (p. 130)
Western Division:	
Hastings, Mill County:	malaria fever in August and September (p. 139)
Council Bluffs, Pottawattamie Co.:	malarial diseases in September

[15] *Ibid.*, p. 126.

The second *Biennial Report* for 1882-1883 (Des Moines 1883) lists in the same way as malarious a much lower number of places: Clermont, Fayette County (p. 160); Sherrills Mount, Dubuque County (several hundred cases, p. 163); Toledo, Tama County (typhoid and other malarial fevers (sic!) less prevalent, p. 187); Centerville, Appanoose County (Aug.-Oct. malarious diseases, p. 191). This Report also contains, in an article of Dr. P. J. Farnsworth on the geology and geography of Iowa, the following remarks on malaria:

> Some cause of special fever prevails all over the State . . . Its general diffusion only happens at rare intervals, yet in every part of the State, in any season a few diseases occur that do not manifest symptoms of this poison, and require antidotes that counteract it. Cultivation of the soil and general drainage may diminish or destroy it; they have not yet done so to any extent (p. 391).

Dr. F. A. Long tells in his memoirs for 1882 that malaria was common in southern Iowa in these days.[16] The fourth *Biennial Report* of the State Board of Health (Des Moines 1887) unfortunately drops the interesting "Special Correspondence," but still says in an anonymous article on "Malarial Influences":

> Iowa is comparatively free from malaria or miasmatic poisoning; yet the total number of deaths, and they represent but a small portion of the cases of malarial disease occurring in the State, is by no means inconsiderable . . . In our own State malaria is most prevalent along the water courses . . . and in swampy districts. (P. 13).

Further Reports do not deal any longer with malaria and in 1915 (for the period 1910-1914) "malaria is reported not to occur in the State."[17] How far this judgment is true only in certain limits, we have already explained in the Introduction.[18]

Iowa seems not to have gone through the epidemiological "latency" period which Illinois and Missouri enjoyed so far as malaria is concerned. On the contrary malaria seems to have started with full vigor almost simultaneously with settlement in the 30's. There is, on the other hand, reason to believe that, especially in northern Iowa, it never fully reached the degree of universality and malignancy it attained in the states located more towards the south. Decline seems to have started relatively early (in the 70's) after about 30 years of prevalence, but seems to have been rather slow and accompanied by the usual epidemic fluctuations. "Disappearance" seems to have occurred around or after 1900. We illustrate this summary as usual by a graph (Fig. 6) and attach a graph of the malaria death rates of the census (Fig. 7).

[16] F. A. Long, 1937, p. 30. [17] Ezdorf, 1915, p. 9. [18] See also A. W. Bennett, 1943.

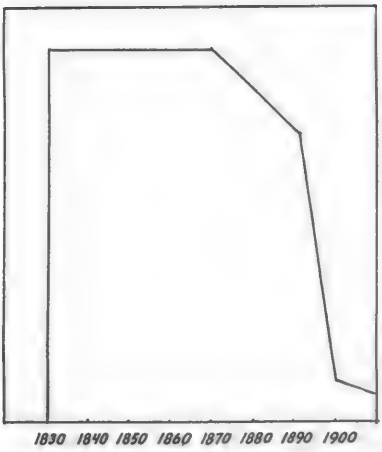

FIG. 6.

MALARIA IN IOWA.

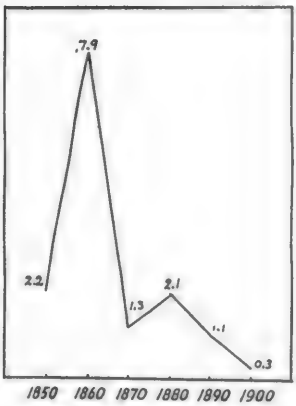

FIG. 7.

IOWA.

Malaria Death Rate in 10,000 Population.

Wisconsin

Wisconsin was first visited by Nicolet in 1634, and through the future state passed all the famous travelers: Joliet, Marquette, Father Allouez, Radisson, Groseilliers, Perrot, Duluth. But it was settled only in the American Period and essentially after the Black Hawk War of 1832. In 1830 Wisconsin had 3,000 inhabitants, in 1840, 30,000 and in 1850, two years after achieving statehood, 300,000. Among its first settlers was a large percentage of Germans and Norwegians, which explains the relatively large amount of Norwegian material among our early malaria data. Economically Wisconsin is known as the Dairy State.[1]

When John Kinzie, Jr., of Chicago was a trader in Prairie du Chien in the 1820's he got malaria, as did everybody who was not yet acclimated.[2] In 1825 a Sioux chief died at Prairie du Chien from "bilious fever."[3] Among the notes of the famous Dr. Beaumont there is a manuscript entitled *History of the Intermittent Fever as it Prevailed at Prairie du Chien the Summer and Fall of 1830.*[4] Beaumont was at that time an army surgeon at Fort Crawford, which from 1829 to 1838 showed an average incidence in intermittent and remittent fever of 300 in 1000,[5] while the more northernly located Fort Winnebago had for the same period only an average of 66 in 1000.[6]

The Norwegian Langland writes in 1839:

> Malarial fever prevailed in the whole Fox River Valley from Muskego in Wisconsin to the Mississippi River in Illinois as well as in other river valleys in the West.[7]

Norwegian settlers suffered terribly from malaria in Clinton and Jefferson Prairie, Rock County, in 1839. The Norwegian settlement in Koshkonong, Dane County, experienced malaria epidemics in 1840, 1844 and 1847. Malaria was general among the Norwegian settlers at Lake Muskego since 1839. In 1841 80 out of less than 600 died from malaria (13 percent!). In 1844 the situation had improved—"only" 17 died.[8] Dr. C. A. Harper of Madison was so kind as to transmit to me the following passage from a letter, written in 1848 in LaGrange, Walworth County:

> Our immediate neighbourhood is healthy at present. People are in fear and

---

[1] All historical data on Wisconsin are taken from Fitzpatrick, 1928.
[2] J. A. Kinzie, 1856, p. 63.
[3] James, 1830, p. 242.
[4] J. S. Myer, 1912, p. 143.
[5] U. S. Army, 1840, p. 155.
[6] *Ibid.*, p. 150.
[7] Hektoen, 1926, p. 19.
[8] *Ibid.*, p. 7.

State Population
3,137,507
County Population
is shown in thousands
with county name
City Population
100,000 and over
25,000 to 100,000
5,000 to 25,000
1,000 to 5,000
under 1,000
State Capital is shown with star-centered symbol
County Seat is shown with dot-centered symbol
Metropolitan Districts are enclosed by dashed lines
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Lake Superior
MINNESOTA
MICHIGAN
WISCONSIN
Duluth
Superior
ST. LOUIS
DOUGLAS 47
BAYFIELD 16
APOSTLE ISLANDS
ASHLAND 22
IRON 10
GOGEBIC
Ironwood
Hurley
Iron River
BURNETT 11
WASHBURN 12
SAWYER 12
VILAS 9
FOREST 12
FLORENCE 4
DICKINSON
Iron Mt.
Kingsford
MENOMINEE
Niagara
MARINETTE 36
POLK 26
BARRON 34
Cumberland
Rice Lake
RUSK 18
PRICE 18
Park Falls
ONEIDA 19
Rhinelander
LINCOLN 23
Tomahawk
LANGLADE 23
Antigo
OCONTO 27
Oconto
Marinette
Menominee
CHISAGO
St Croix Falls
Amery
POLK
BURNETT
WASHBURN
SAWYER
TAYLOR 20
Rib Lake
Merrill
CHIPPEWA 41
Cornell
Bloomer
SAINT CROIX 25
New Richmond
DUNN 27
Boyceville
Colfax
Menomonie
Chippewa Falls
Stanley
CLARK 34
Thorp
Abbotsford
Greenwood
Loyal
Unity
MARATHON 76
Wausau
Schofield
Mosinee
Spencer
SHAWANO 35
Shawano
Gillett
Oconto Falls
Ocunto
Sturgeon Bay
DOOR 19
PIERCE 21
Ellsworth
PEPIN 8
Durand
EAU CLAIRE 47
Eau Claire
Altoona
Augusta
Fall Creek
Elk Mound
Menomonie
WOOD
Marshfield
44
PORTAGE 36
Stevens Point
WAUPACA 35
Waupaca
OUTAGAMIE 70
Green Bay
De Pere
KEWAUNEE 17
BROWN 83
Kaukauna
Little Chute
Hortonville
New London
Wisconsin Rapids
Port Edwards
Nekoosa
BUFFALO 16
Mondovi
JACKSON 17
TREMPEALEAU 21
Whitehall
Independence
Osseo
Blair
Taylor
Black River Falls
Hixton
Alma
Pray
Granton
Neillsville
Humbird
Merrillan
Hatfield
Pigeon Falls
Arcadia
Galesville
Ettrick
Trempealeau
WABASHA
GOODHUE
Red Wing
Hastings
DAKOTA
WASHINGTON
Stillwater
Hudson
River Falls
Prescott
Hammond
Somerset
New Auburn
Bruce
Ladysmith
Rusk
Sheldon
Tony
Glen Flora
Hawkins
Ingram
Kennan
Ogema
Catawba
Brantwood
Prentice
Phillips
Lugerville
Fifield
Draper
Loretta
Winter
Couderay
Radisson
Exeland
Reserve
Stone Lake
Hayward
Spooner
Shell Lake
Sarona
Webster
Siren
Grantsburg
Danbury
Trade River
Gushing
Luck
Milltown
Centuria
Balsam Lake
Osceola
Dresser
Clayton
Turtle Lake
Barron
Cameron
Almena
Hillsdale
Chetek
Dallas
Prairie Farm
Clear Lake
Star Prairie
Ridgeland
Sand Creek
Glenwood City
Woodville
Wilson
Knapp
Roberts
Elmwood
Spring Valley
Ellsworth
Prescott
Plum City
Maiden Rock
Stockholm
Pepin
Arkansaw
Mondovi
Gilmanton
Modena
Nelson
Pigeon Falls
Fountain City
Alma Center
Hixton
Pray
Whitehall
Independence
Alma
Buffalo City
Cochrane
Fountain City
Winona
Lamoille
Minnesota City
Rollingstone
Saint Charles
Dover
Eyota
Stockton
Utica
Homer
Witoka
Minnesota City
Winona
Goodview
Lewiston
Altura

WISCONSIN
71 Counties
MINNESOTA
POLK 26
BARRON 34
RUSK 18
TAYLOR 20
CHIPPEWA 41
DUNN 27
SAINT CROIX 25
PIERCE 21
PEPIN 8
EAU CLAIRE 47
CLARK 34
BUFFALO 16
TREMPEALEAU 28
JACKSON 17
LA CROSSE 60
MONROE 30
WOOD 44
PORTAGE 36
MARATHON 76
LINCOLN 23
LANGLADE 23
MARINETTE 36
OCONTO 27
SHAWANO 35
WAUPACA 35
OUTAGAMIE 70
BROWN 83
KEWAUNEE 17
DOOR 19
MANITOWOC 63
WINNEBAGO 81
CALUMET 18
WAUSHARA 14
ADAMS 8
JUNEAU 19
MARQUETTE 9
GREEN LAKE 14
MENOMINEE
Rhinelander
Merrill
Wausau
Stevens Point
Wisconsin Rapids
Marshfield
Tomahawk
Antigo
Shawano
Appleton
Oshkosh
Green Bay
De Pere
Menasha
Neenah
Manitowoc
Two Rivers
Sturgeon Bay
Marinette
Menominee
Oconto
Oconto Falls
Gillett
Peshtigo
Eau Claire
Chippewa Falls
Menomonie
Rice Lake
Cumberland
Hudson
New Richmond
River Falls
Prescott
Ellsworth
Stillwater
Red Wing
Hastings
Winona
La Crosse
Sparta
Tomah
Black River Falls
Neillsville
Merrill
Wausau
Rib Lake
Phillips
Ladysmith
Bloomer
Cornell
Durand
Arcadia
Whitehall
Independence
Alma
Galesville
Trempealeau
Osseo
Augusta
Fairchild
Thorp
Abbotsford
Colby
Edgar
Schofield
Rothschild
Mosinee
Kronenwetter
Weston
Hatley
Norrie
Elderon
Tigerton
Bowler
Birnamwood
Eland
Keshena
Gillett
Suring
Oconto
Oconto Falls
Pensaukee
Abrams
Big Suamico
Bonduel
Pulaski
Seymour
Black Creek
Shiocton
Freedom
Kaukauna
Little Chute
Combined Locks
Kimberly
Hortonville
Clintonville
Embarrass
Big Falls
Marion
Iola
Scandinavia
Marawa
Royalton
Waupaca
New London
Weyauwega
Fremont
Manawa
Larsen
Winneconne
Omro
Eureka
Pickett
Fox Lake
Wild Rose
Pine River
Poy Sippi
Wautoma
Coloma
Lohrville
Spring Lake
Red Granite
Berlin
Princeton
Green Lake
Kiel
New Holstein
Chilton
Brillion
Reedsville
Kellnersville
Mishicot
Valders
Kewaunee
Luxemburg
Casco
Algoma
Sturgeon Bay
Egg Harbor
Fish Creek
Ephraim
Sister Bay
Ellison Bay
Gills Rock
Washington Island
Rock Island
Detroit Harbor
Jacksonport
Baileys Harbor
Whitefish Bay
Green Bay
Lake Michigan
Lake Winnebago
Lake Poygan
Lake Butte des Morts
Lake Winneconne
Lake Shawano
Lake Noquebay
Lake Metonga
Lake Antigo
Lake Nokomis
Lake Mohawksin
Lake Nepahwin
Lake Wabeno
Lake Superior
Lake Michigan

72 Counties
8 449 Adams J 16
21,801 Ashland G 8
34,789 Barron D 10
15,827 Bayfield E 5
63,109 Brown O 14
16,090 Buffalo D 14
11,382 Burnett B 8
17,618 Calumet O 15
40,703 Chippewa E 11
33,972 Clark G 13
22,517 Columbia K 18
18,108 Crawford F 19
130,660 Dane K 20
54,280 Dodge M 19
19,085 Door Q 12
47,119 Douglas C 6
27,375 Dunn C 12
46,999 Eau Claire E 13
4,177 Florence N 8
62,353 Fond du Lac N 17
11,805 Forest M 9
30,639 Grant Q 21
23,146 Green J 22
14,092 Green Lake L 16
20,595 Iowa I 20
10,049 Iron H 8
16,399 Jackson G 15
38,868 Jefferson M 20
18,709 Juneau I 16
63,905 Kenosha O 22
16,680 Kewaunee P 14
96,653 La Crosse D 16
16,695 Lafayette I 22
23,727 Langlade L 10
22,536 Lincoln J 10
61,617 Manitowoc P 15
75,915 Marathon J 12
36,225 Marinette Q 10
9,097 Marquette K 17
756,885 Milwaukee O 20
30,080 Monroe G 18
27,075 Oconto N 12
18,838 Oneida J 9
70,032 Outagamie N 14
18,985 Ozaukee O 19
7,897 Pepin C 12
21,471 Pierce B 13
25,197 Polk B 9
35,800 Portage K 16
18,467 Price H 9
96,047 Racine O 21
20,381 Richland H 19
80,173 Rock L 22
17,737 Rusk F 9
74,847 Saint Croix B 11
33,700 Sauk I 19
11,540 Sawyer F 8
35,378 Shawano M 12
76,221 Sheboygan O 17
20,105 Taylor H 11
24,381 Trempealeau E 14
29,940 Vernon G 18
8,894 Vilas K 7
33,103 Walworth N 22
12,496 Washburn D 8
28,430 Washington O 19
62,744 Waukesha N 20
34,614 Waupaca L 14
14,268 Waushara K 15
80,507 Winnebago M 18
44,465 Wood I 14
3,137,587 State Total
SCALE IN MILES
0 5 10 20 30 40
LA CROSSE 60
Trempealeau
Holmen
Onalaska
W. Salem
Bangor
HOUSTON
La Crosse
Angelo
Tomah
Sparta
Oleon
Clifton
Norwalk
Kendall
Cashton
VERNON 30
Coon Valley
Chaseburg
Westby
Stoddard
Genoa
Viroqua
Ontario
Hillsboro
La Farge
ALLAMAKEE
De Soto
Readstown
CRAWFORD 18
Soldiers Grove
Mt. Sterling
Gays Mills
Seneca
Steuben
RICHLAND 20
Viola
Cazenovia
Richland Center
Boaz
Bear Valley
Lone Rock
Gotham
Muscoda
Boscobel
Prairie du Chien
Wauzeka
Woodman
CLAYTON
GRANT 41
Fennimore
Mt. Hope
Montfort
Bloomington
Livingston
Glenhaven
Lancaster
IOWA
Cassville
Platteville
Potosi
DUBUQUE
Cuba City
Dickeyville
Hazel Green
Dubuque
JO DAVIESS
Necedah
Camp Douglas
New Lisbon
Hustler
Mauston
Elroy
Lyndon
Wonewoc
SAUK 34
Lake Delton
Reedsburg
Ableman
Loganville
North Freedom
Leland
Prairie du Sac
Sauk City
Plain
Spring Green
IOWA 21
Arena
Highland
Barneveld
Ridgeway
Cobb
Dodgeville
Linden
Hollandale
Rewey
Mineral Point
LAFAYETTE 19
Blanchardville
Belmont
Darlington
Argyle
Benton
Shullsburg
Gratiot
New Diggings
S. Wayne
Friendship
Adams
Grand Marsh
Brooks
Oxford
Plainfield
Packwaukee
Endeavor
Markesan
Manchester
Montello
Westfield
Harrisville
Neshkoro
MARQUETTE 9
Berlin
GREEN LAKE 14
Princeton
Green Lake
Spring Lake
Omro
Eureka
Oshkosh
Pickett
Winneconne
Neenah
Menasha
New Holstein
Kiel
Chilton
Stockbridge
Navarino
Ripon
Fond du Lac
N. Fond du Lac
FOND DU LAC 62
Brandon
Alto
Eden
Oakfield
Waupun
Mayville
Kekosee
Lomira
Fox Lake
DODGE 54
Beaver Dam
Juneau
Horicon
Iron Ridge
Randolph
Portage
Cambria
Friesland
COLUMBIA 33
Wisconsin Dells
Lodi
Arlington
Columbus
Pardeeville
Poynette
Rio
Fall River
Merrimac
Baraboo
Wyocena
DANE 13
Dane
De Forest
Waunakee
Marshall
Mazomanie
Black Earth
Sun Prairie
Middleton
Madison
Cottage Grove
Shorewood Hills
Cambridge
Deerfield
Oregon
Verona
Mount Horeb
Stoughton
Utica
Albion
Dayton
Brooklyn
GREEN 23
New Glarus
Monticello
Albany
Brodhead
Monroe
Juda
Gratiot
Shullsburg
Footville
Orfordville
Janesville
ROCK 80
Edgerton
Milton
Milton Jc.
Evansville
Beloit
Shopiere
Clinton
Rockton
Rockford
Freeport
Belvidere
Woodstock
Whitewater
WALWORTH 31
E. Troy
Elkhorn
Lyons
Delavan
Lake Geneva
Walworth
Sharon
Genoa City
Twin Lakes
Brookfield
Elm Grove
Menomonee Falls
Germantown
Menomonee
Hartland
Pewaukee
Waukesha
WAUKESHA 63
Sussex
Lisbon
Oconomowoc
Johnson Creek
Lake Mills
Jefferson
Sullivan
Fort Atkinson
Palmyra
Eagle
Watertown
Waterloo
JEFFERSON 39
Hebron
Milwaukee
MILWAUKEE 767
Wauwatosa
West Allis
Cudahy
S. Milwaukee
Oak Creek
Franklin
Greendale
Caledonia
Mukwonago
Muskego
New Berlin
Brookfield
Elm Grove
Whitefish Bay
Shorewood
Fox Point
Bayside
Glendale
Milwaukee
Racine
Kenosha
Waukegan
Chicago
Marion
Cedar Rapids
Sheboygan
Sheboygan Falls
Plymouth
Kohler
Elkhart Lake
Glenbeulah
Howards Grove
Cascade
Random Lake
Cedar Grove
Oostburg
Campbellsport
Kewaskum
Barton
Fredonia
Belgium
Port Washington
Saukville
Grafton
Cedarburg
Slinger
Hartford
Pewaukee
Lake Five
Lake Nagawicka
Lake Pewaukee
Okauchee Lake
Lannon
Sussex
Lisbon
Merton
Summit
Oconomowoc Lake
Dousman
Big Bend
Muskego
Wind Lake
Waterford
Ives
Sturtevant
Burlington
Union Grove
Silver Lake
Salem
Bristol
Paddock Lake
Twin Lakes
Wilmot
Antioch
Lake Michigan
IOWA
ILLINOIS
DUBUQUE
JO DAVIESS
STEPHENSON
WINNEBAGO
BOONE
McHENRY
LAKE
RACINE 84
KENOSHA 64
SHEBOYGAN 75
WASHINGTON 88
OZAUKEE 19
A B C D E F G H I J K L M N O P Q R
1 2 3 4 5

tremble, for in every direction all around them, it is very sickly with fever and ague and chilled fever and bilious fever.

Prairie du Chien was still very unhealthy in the 40's from malaria and typhoid. but nearby Fort Atkinson was healthy.[9] An uninteresting article of Dr. H. Hunt, Delavan, on malaria in the *Boston Medical and Surgical Journal* (1846, 34: 241 ff.) shows nevertheless the existence of malaria in Wisconsin.

Drake, our main source for the 1840's, has relatively little to say of Wisconsin. Local doctors told him that at Madison and the Fox River "a few mild intermittents make up the sum total of an autumnal invasion." But there had been one epidemic at Madison and at Janesville (I, 328). In Mineral Point "the people who live near the stream below the town are subject to autumnal fever, from which the inhabitants of the town itself are not entirely exempt" (I, 329). Drake also mentions the prevalence of malaria in Racine and Milwaukee (II, p. 106). The great quantities of quinine consumed in Milwaukee during the 40's speak for the malariousness of the place.[10]

Frederika Bremer, the Swedish female traveler in the Northwest of the 50's who wrote in poetic language, paid little attention to health conditions. But she notes that an old Norwegian peasant in Wisconsin told her dryly: "Health is better in the old country."[11] Malaria went on during the 50's as retrospective reports published in the 70's reveal.

Dr. C. A. Harper of Madison, to whom I am very much indebted for his kind interest in this study, has given from his own experience the following graphic description of what was malaria in the 70's in certain parts of Wisconsin:

I was born in southwestern Wisconsin near the Illinois line in 1864, and in the 70's I have full recollection of having malaria every summer for many summers, and other members of the family were also afflicted. We took the prevalence of malaria, in the summer in the '70's especially, as a matter of course, and for months every summer on every third day, I would have a chill about noon, a temperature of about 105° following the chill and excessive perspiration following the fever. In the autumn and winter we were not so troubled. Eventually, none of us were troubled with malaria during the summer months. The cause of the disappearance is really unknown.

The *Proceedings* of the Wisconsin State Board of Health, published since 1877, contain a number of references to malaria and typhoid fever. Of *Page* it is reported in 1877:

[9] R. S. Holmes, 1848, p. 528.
[10] Kremers, 1931, p. 143.
[11] F. Bremer, 1853, I, p. 634.

Intermittent fever is seldom met with here. Remittent or bilious is rather infrequent and often assumes a continuous form. Typhus is very rare. I have had but few cases and those among newly arrived emigrants who had been recently exposed to "ship fever." Typhoid on the contrary is the prevailing fever in this region.

Prairie du Chien (Wis. Bd. of Health, II, 1878, p. 143):

On the borders of streams malarial fevers have prevailed to some extent.

Douglas Centre (Wis. Bd. of Health, II, 1878, p. 136):

Intermittents are very rare. The fevers begin as remittent, terminating in typhoid symptoms. The country is much healthier than at its settlement 25 years ago.

Chippewa Falls (Wis. Bd. of Health, II, p. 135):

Remittent and continued fevers of a severe type with typhoid symptoms prevailed during September, diminishing to November.

Volume III of the same publication (1879) reports "a much larger amount of remittents and intermittents than usual" for Benton (p. 148), "typhomalaria fevers" for Geneva (p. 153), "bilious, intermittent and remittent fevers" for Retreat (p. 160), "ague very prevalent" for Richland Center (p. 161), "bilious and intermittent fevers" for St. Martin. Beloit (*ibid.*, p. 148) has "very much intermittent fever, usually quotidian in type, in within a radius of one-half mile from the mill pound and nearly all along the river." Hirsch (1881, p. 159) mentions Winnebago as being free from malaria.

The Ninth *Report* of the Wisconsin State Board of Health (1885, p. 92) states:

Malaria disease is reported occurring in but a few and widely scattered localities. LaFayette, Marquette, Oconto, Outagamie, Pierce and Racine county are those wherein its existence is reported, but such reports come from no more than one or two towns in any of the counties mentioned.

Then malaria is no further mentioned in the Reports until the incorporation of vital statistics in 1911. Dr. Harper writes in a personal communication: "I have been on the State Board of Health since 1901 and the problem of malaria was never of such a type that the Board of Health became concerned with its prevalence . . . The last few years there were occasional cases of malaria—very few however." [12]

It seems that malaria in Wisconsin never became so general as in more southern locations, that it was mainly limited to river and lake bottoms,

[12] See also Introduction and Sanford, 1913.

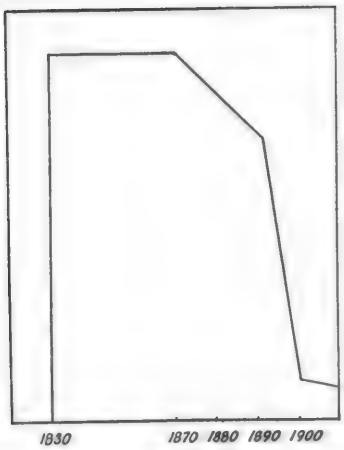


FIG. 8.

MALARIA IN WISCONSIN.

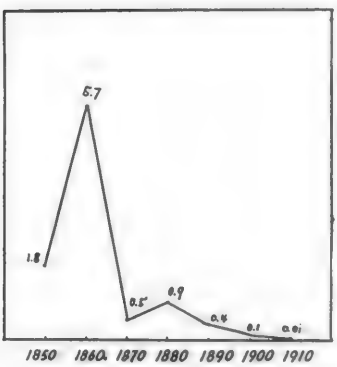


FIG. 9.

WISCONSIN.

Malaria Death Rate in 10,000 Population.

and that the proportion between typhoid and malaria was always more one of equality. But on the other hand I think our research reveals that it was bad enough during decades, much worse than might generally be assumed or expected in such latitudes.

In Wisconsin, as in Iowa, malaria, it seems, did not follow settlement at a certain distance, but rather went parallel with settlement. Promptly in the 30's it went up to a high level of endemicity, beginning a slow decline in the 60's, interrupted by local epidemics and completed during the 90's (see Fig. 8). We give in Fig. 9 the results of the malaria death rate statistics, abstaining from a discussion of the possible contradictions between these statistics (which would bring out the disappearance of malaria in the 1860's) and our text, for reasons outlined above.

Minnesota

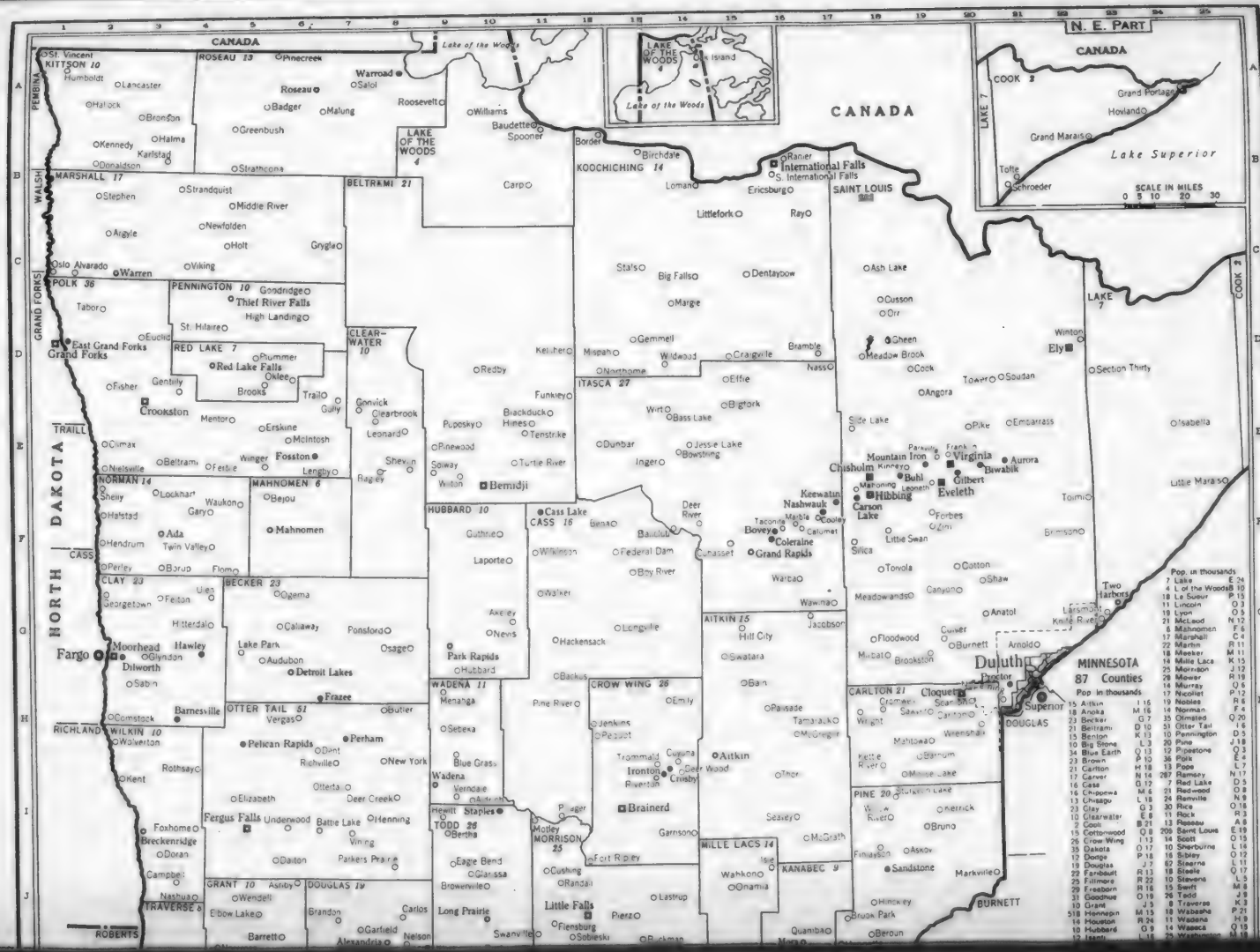
With Minnesota we reach the last, the northernmost and the youngest of the states under observation. Again we have a long list of illustrious travelers who roamed in the state: Radisson and Groseilliers (1655), Father Hennepin, Duluth, Nicolet, Perrot, Lesueur, Verandrye, Penicaut, Carver, Pike. But settlement took place only in the 40's. In 1850 the state had still only 6,000 inhabitants, but five years later there were already 70,000 Minnesotans, among them many Germans and Norwegians. In 1858 Minnesota became a state. Lumbering was the first industry; railroads came only in the 60's. After the Civil War and an Indian war in 1867, there was a new wave of immigration and in the 90's a third one.[1]

The earliest records we could obtain on malaria in Minnesota are the army statistics from Fort Snelling with the low average morbidity rate from intermittents and remittents of 66 in 1000 per year during the decade 1829-1838.[2] Army surgeon R. S. Holmes informs us for the 1840's that:

> At the Falls of St. Anthony in the latitude of 45 degrees the Indians have suffered very much and great numbers have died from intermittent fever. It seemed that that fever had been known only among them within the last 2 or 3 years.[3]

Drake has little to say of Minnesota which, after all, was still a wilderness in his day. He mentions the limited prevalence of malaria at Fort Snelling and at Stillwater.[4] When St. Paul was not yet quite a year old the *Minnesota Pioneer* (its first number, April 28, 1849) announces quite

[1] Historical data for Minnesota are taken from Parsons, 1918.
[2] U. S. Army, 1840, p. 147.
[3] R. S. Holmes, 1848, p. 528.
[4] Drake, I, p. 330.


CANADA
Lake of the Woods
LAKE OF THE WOODS 4
Lake of the Woods
CANADA
N. E. PART
CANADA
COOK 2
LAKE 7
Grand Portage
Hovland
Grand Marais
Lake Superior
Toffe
Schroeder
SCALE IN MILES
0 5 10 20 30
PEMBINA
WALSH
GRAND FORKS
NORTH DAKOTA
CASS
TRAILL
RICHLAND
WILKIN 10
ROBERTS
MARSHALL 17
POLK 36
NORMAN 14
CLAY 23
OTTER TAIL 51
GRANT 10
TRAVERSE 6
DOUGLAS 19
STEVENS
POPE
STEARNS
BENTON
MORRISON 25
TODD 26
WADENA 11
BECKER 23
MAHNOMEN 6
HUBBARD 10
CLEARWATER 10
BELTRAMI 21
PENNINGTON 10
RED LAKE 7
LAKE OF THE WOODS 4
ROSEAU 13
KOOCHICHING 14
ITASCA 27
CASS 16
CROW WING 26
AITKIN 15
MILLE LACS 14
KANABEC 9
SAINT LOUIS
LAKE 7
COOK 2
PINE 20
CARLTON 21
DOUGLAS
BURNETT
St. Vincent
KITTSON 10
Humboldt
Lancaster
Hallock
Bronson
Kennedy
Halma
Karlstad
Donaldson
Strathcona
Roseau
Pinecreek
Warroad
Salol
Badger
Malung
Greenbush
Roosevelt
Williams
Baudette
Spooner
Border
Birchdale
Ranier
International Falls
S. International Falls
Loman
Ericsburg
Littlefork
Ray
Stephen
Strandquist
Middle River
Newfolden
Argyle
Holt
Gryglo
Carpo
Oslo
Alvarado
Warren
Viking
Taboro
Euclid
East Grand Forks
Grand Forks
Fisher
Gentilly
Crookston
Mentor
Climax
Nielsville
Beltrami
Fertile
Winger
Fosston
Lengby
Erskine
McIntosh
Trail
Gully
Gonvick
Clearbrook
Leonard
Shevlin
Ragley
Bemidji
Redby
Kelliher
Mispah
Northome
Wildwood
Craigville
Bramble
Nass
Effie
Bigfork
Funkley
Blackduck
Hines
Tenstrike
Pupesky
Pinewood
Turtle River
Solway
Wilton
Dunbar
Jessie Lake
Bowstring
Inger
Wirt
Bass Lake
Gemmell
Big Falls
Dentaybow
Marge
Stats
Ash Lake
Cusson
Orr
Sheen
Meadow Brook
Cook
Winton
Ely
Section Thirty
Angora
Tower
Soudan
Side Lake
Pike
Embarrass
Isabella
Parkville
Frank
Mountain Iron
Virginia
Aurora
Biwabik
Kinney
Chisholm
Buhl
Gilbert
Mahoning
Leonetti
Eveleth
Hibbing
Carson Lake
Forbes
Gilman
Little Swan
Brimson
Toimi
Little Marais
Silica
Tonola
Gaston
Shaw
Canyon
Meadowlands
Anatol
Two Harbors
Larsmont
Knife River
Floodwood
Gowser
Burnett
Arnold
Brookston
Mirbat
Duluth
Proctor
Superior
Wrenshall
Cloquet
Scanlon
Carlton
Wright
Mahtowa
Barnum
Moose Lake
Kettle River
Automn Lake
Willow River
Nemrick
Bruno
Finlayson
Askov
Sandstone
Markville
Hinckley
Brook Park
Beroun
Quamba
Pine River
Jenkins
Pequot
Trommald
Cuyuna
Ironton
Crosby
Deerwood
Riverton
Aitkin
Thor
Brainerd
Garrison
Seavey
McGrath
Palisade
Tamarack
McGregor
Bain
Emily
Swatara
Hill City
Jacobson
Longville
Hackensack
Backus
Walker
Akeley
Nevis
Park Rapids
Hubbard
Laporte
Guthrie
Cass Lake
Bena
Ball Club
Deer River
Federal Dam
Boy River
Wilkinson
Walker
Remer
Onigum
Bowe
Taconite
Marble
Cooley
Calumet
Keewatin
Nashwauk
Coleraine
Grand Rapids
Warba
Wawina
Meadowlands
Canyon
Gary
Waukon
Lockhart
Sheely
Halstad
Hendrum
Ada
Twin Valley
Perley
Borup
Flom
Bejou
Mahnomen
Felton
Ulen
Georgetown
Hitterdal
Moorhead
Hawley
Glyndon
Dilworth
Fargo
Sabin
Comstock
Barnesville
Ogema
Callaway
Ponsford
Lake Park
Audubon
Detroit Lakes
Osage
Frazee
Vergas
Butler
Pelican Rapids
Perham
Dent
Richville
New York
Rothsay
Kent
Elizabeth
Otterdale
Deer Creek
Fergus Falls
Underwood
Battle Lake
Henning
Vining
Parkers Prairie
Foxhome
Breckenridge
Doran
Campbell
Nashua
Dalton
Ashby
Wendell
Elbow Lake
Barrett
Brandon
Carlos
Garfield
Alexandria
Nelson
Menahga
Sebeka
Blue Grass
Wadena
Verndale
Hewitt
Staples
Bertha
Eagle Bend
Clarissa
Browerville
Long Prairie
Swanville
Motley
Fort Ripley
Cushing
Randall
Little Falls
Flensburg
Sobieski
Pierz
Lastrup
Watkins
Onamia
Isle
Milaca
Foley
Princeton
Zimmerman
Becker
Big Lake
Elk River
Anoka
Coon Rapids
Minneapolis
St. Paul
Rochester
Austin
Albert Lea
Mankato
New Ulm
Worthington
Fairmont
Winnebago
Blue Earth
Waseca
Owatonna
Faribault
Northfield
Red Wing
Hastings
Stillwater
Cambridge
Isanti
Chisago City
Lindstrom
Wyoming
Forest Lake
Hugo
White Bear Lake
Stillwater
Hudson
Wisconsin
Minnesota
Iowa
MINNESOTA
87 Counties
Pop. in thousands
Pop. in thousands

NORTH DAKOTA
Fargo
Moorhead
Hawley
Dilworth
Sabin
Barnesville
Comstock
Wolverton
Rothsay
Kent
Foxhome
Breckenridge
Doran
Campbell
Nashua
Wheaton
Dumont
Browns Valley
Mahnomen
Ada
Twin Valley
Hendrum
Perley
Borup
Ulen
Georgetown
Felton
Hitterdal
Ogema
Callaway
Ponsford
Lake Park
Audubon
Detroit Lakes
Osage
Frazee
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Underwood
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Vining
Parker's Prairie
Dalton
Fergus Falls
Wendell
Ashby
Elbow Lake
Barrett
Norcross
Hoffman
Herman
Brandon
Carlos
Garfield
Alexandria
Nelson
Osakis
Kensington
Donnelly
Morris
Lowry
Glenwood
Villard
Starbuck
Guthrie
Laporte
Axley
Nevis
Hubbard
Park Rapids
Menahga
Sebeka
Blue Grass
Wadena
Verndale
Hewitt
Staples
Bertha
Eagle Bend
Clarissa
Browerville
Long Prairie
Swanville
Burtrum
West Union
Grey Eagle
Upsala
Bowlus
St. Rosa
Sauk Center
Melrose
Freeport
Albany
Holdingford
Avon
Sartell
Cass Lake
Benoa
Wilkinson
Federal Dam
Bay River
Walker
Longville
Backus
Pine River
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Crow Wing
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Brainerd
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Royalton
Rice
Gilman
Foley
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Sauk Rapids
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Rice
Gilman
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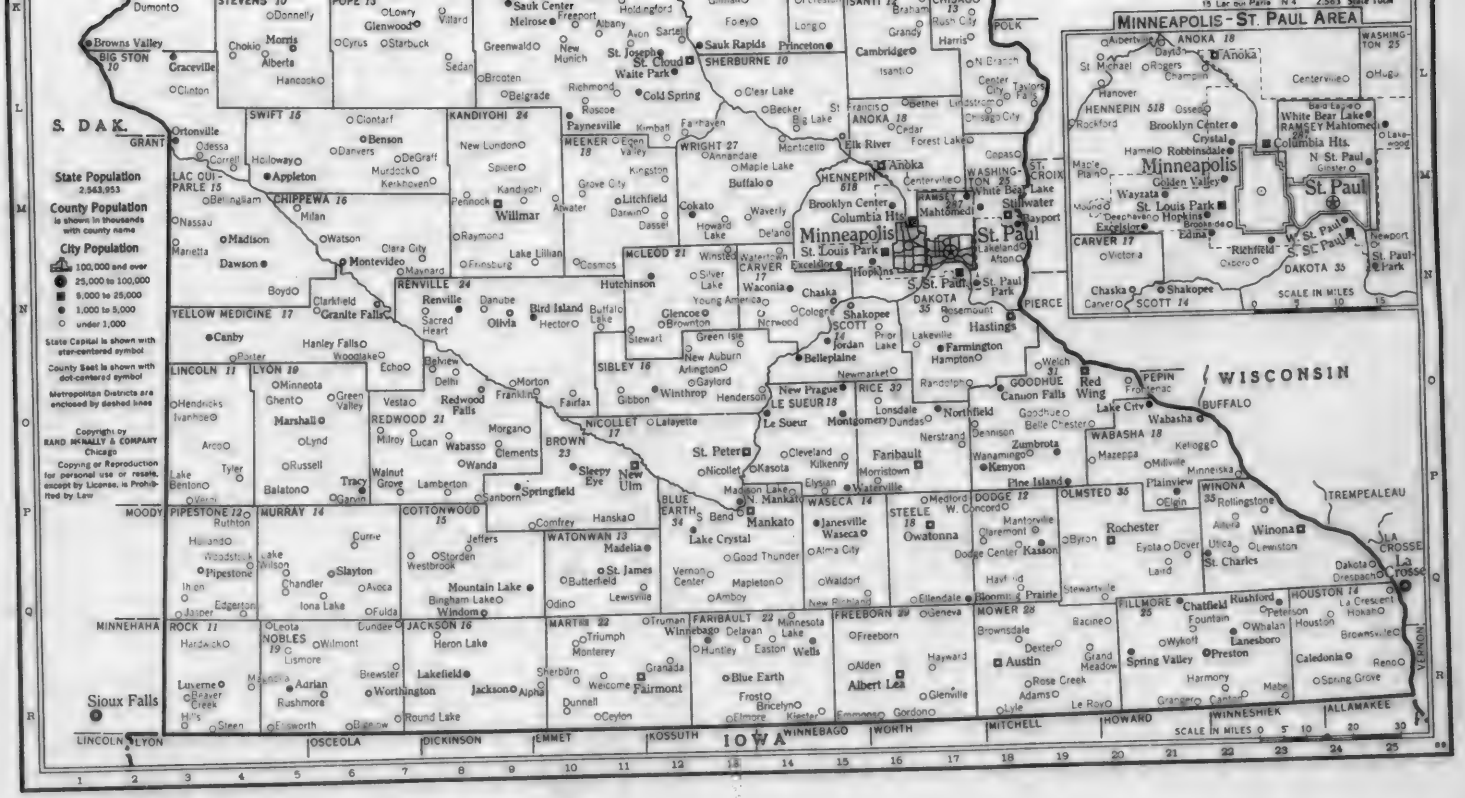
Benton
Sauk Rapids
Bayport
Tacoma
Marble
Coleraine
Bovey
Calumet
Cohasset
Grand Rapids
Warba
Wawina
Jacobson
Hill City
Swatara
Bain
Palisade
Tamarack
McGregor
Aitkin
Deerwood
Ther
Seavey
McGrath
Isle
Wahkon
Onamia
Mille Lacs
Kanabec
Quamba
Mora
Ogilvie
Grasston
Milaca
Ereston
Longo
Braham
Isanti
Grandy
Chisago
Rush City
Harris
Polk
Carson Lake
Forbes
Zim
Little Swan
Brimson
Silica
Toivola
Cotton
Shaw
Meadowlands
Canyon
Anatol
Two Harbors
Larsmont
Knife River
Floodwood
Culver
Burnett
Arnold
Mirbat
Brockston
Duluth
Proctor
Superior
Douglas
Carlton
Cloquet
Cromwell
Scanlon
Wright
Sawyer
Carlton
Wrenshall
Mahtowa
Barnum
Kettle River
Mouse Lake
Pine
Sturgeon Lake
Willow River
Kerrick
Bruno
Finlayson
Askov
Sandstone
Hinckley
Brook Park
Beroun
Henriette
Pine City
Burnett
Markville
Minnesota
87 Counties
Pop in thousands
Pop. in thousands
Minneapolis - St. Paul Area
Anoka
Washington
Polk
Roberts
Traverse
Grant
Douglas
Stevens
Pope
Stearns
Todd
Morrison
Wadena
Clay
Becker
Otter Tail
Wilkin
Richland
Kittson
Pennington
Red Lake
Clearwater
Mahnomen
Norman
Polk
Pope
Douglas
Grant
Traverse
Big Stone
Swift
Chippewa
Lac qui Parle
Yellow Medicine
Lincoln
Lyon
Lincoln
Murray
Cottonwood
Watonwan
Jackson
Martin
Faribault
Fillmore
Houston
Winona
Wabasha
Goodhue
Wright
Sherburne
Isanti
Chisago
Pine
Kanabec
Mille Lacs
Aitkin
Carlton
Cook
Lake
St. Louis
Koochiching
Itasca
Cass
Crow Wing
Morrison
Benton
Stearns
Meeker
Kandiyohi
Renville
Redwood
Brown
Nicollet
Le Sueur
Rice
Steele
Dodge
Olmsted
Winona
Waseca
Blue Earth
Faribault
Martin
Watonwan
Cottonwood
Jackson
Nobles
Rock
Pipestone
Murray
Lincoln
Lyon
Lake of the Woods
Roseau
Marshall
Pennington
Red Lake
Polk
Norman
Mahnomen
Clay
Becker
Otter Tail
Wilkin
Richland
Kittson
2,563 State Total


MINNEAPOLIS - ST. PAUL AREA
Minneapolis
St. Paul
S. DAK.
IOWA
WISCONSIN
State Population
2,563,953
County Population
is shown in thousands with county name
City Population
100,000 and over
25,000 to 100,000
5,000 to 25,000
1,000 to 5,000
under 1,000
State Capital is shown with star-centered symbol
County Seat is shown with dot-centered symbol
Metropolitan Districts are enclosed by dashed lines
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SCALE IN MILES
Sioux Falls
Mankato
Rochester
Winona
La Crosse
Albert Lea
Austin
Fairmont
Worthington
Willmar
Hutchinson
Owatonna
Faribault
Northfield
Red Wing
Hastings
Stillwater
Anoka
Brooklyn Center
Columbia Hts.
White Bear Lake
Mahtomedi
Roseville
Lakeville
Apple Valley
Eagan
Burnsville
Bloomington
Richfield
Edina
St. Louis Park
Golden Valley
Plymouth
Maple Grove
Coon Rapids
Blaine
Fridley
Shoreview
Arden Hills
New Brighton
Mounds View
Roseville
Falcon Heights
Lauderdale
Maplewood
North St. Paul
Oakdale
Woodbury
Cottage Grove
Hastings
Rosemount
Inver Grove Heights
South St. Paul
West St. Paul
Mendota Heights
Eagan
Apple Valley
Lakeville
Farmington
Hampton
Randolph
Cannon Falls
Red Wing
Lake City
Wabasha
Kellogg
Minneiska
Plainview
Elgin
Mazeppa
Zumbrota
Wanamingo
Kenyon
Pine Island
Dodge Center
Claremont
Mantorville
Byron
Kasson
Stewartville
Chatfield
Fountain
Whalan
Lanesboro
Preston
Spring Valley
Harmony
Caledonia
Houston
Rushford
Peterson
Hokah
La Crescent
Brownsville
Reno
Spring Grove
Mabel
Canton
Granger
Carimona
Le Roy
Adams
Rose Creek
Lyle
Austin
Brownsdale
Grand Meadow
Racine
Dexter
Hayward
Glenville
Albert Lea
Alden
Freeborn
Geneva
Emmons
Conger
Ellendale
Bricelyn
Kiester
Frost
Blue Earth
Winnebago
Delavan
Huntley
Easton
Wells
Minnesota Lake
Truman
Fairmont
Granada
Welcome
Sherburn
Dunnall
Ceylon
Martin
Monterey
Triumph
Heron Lake
Jackson
Alpha
Lakefield
Round Lake
Brewster
Worthington
Rushmore
Adrian
Ellsworth
Steen
Hills
Luverne
Beaver Creek
Magnolia
Hardwick
Leota
Dundee
Wilmont
Lismore
Nobles
Rock
Pipestone
Ihlen
Jasper
Edgerton
Ruthton
Holland
Woodstock
Lake Wilson
Chandler
Avoca
Iona
Lake
Fulda
Slayton
Currie
Murray
Jeffers
Westbrook
Storden
Cottonwood
Mountain Lake
Bingham Lake
Windom
Odin
Watonwan
Madelia
St. James
Butterfield
Lewisville
Vernon Center
Lake Crystal
Good Thunder
Mapleton
Amboy
Waldorf
Janesville
Waseca
Alma City
New Richland
Medford
Steele
Owatonna
Dodge
Claremont
Mantorville
Byron
Kasson
Dodge Center
Stewartville
Olmsted
Rochester
Eyota
Dover
Elgin
Winona
Rollingstone
Altura
Lewiston
Utica
St. Charles
Dakota
Dresbach
La Crosse
Houston
Fillmore
Trempealeau
Buffalo
Wabasha
Goodhue
Belle Chester
Pepin
Frontenac
Lake City
Red Wing
Welch
Goodhue
Canon Falls
Hastings
Farmington
Hampton
Randolph
Northfield
Dennison
Nerstrand
Lonsdale
Dundas
Faribault
Morristown
Waterville
Montgomery
Le Sueur
Le Sueur
New Prague
Henderson
Gaylord
Winthrop
Gibbon
Sibley
Arlington
New Auburn
Green Isle
Stewart
Glencoe
Brownton
Hutchinson
Silver Lake
Young America
Winsted
Watertown
Waconia
Chaska
Cologne
Norwood
Carver
Shakopee
Jordan
Prior Lake
Belle Plaine
Newmarket
Scott
Dakota
Rosemount
Lakeville
Apple Valley
Eagan
Burnsville
Bloomington
Richfield
Edina
St. Louis Park
Hopkins
Minnetonka
Excelsior
Deephaven
Wayzata
Orono
Medina
Maple Plain
Independence
Loretto
Greenfield
Corcoran
Rockford
Hamel
Dayton
Champlin
Anoka
Ramsey
Andover
Coon Rapids
Blaine
Centerville
Lino Lakes
Circle Pines
Hugo
Washington
Lake Elmo
Oakdale
Woodbury
Cottage Grove
Newport
St. Paul Park
Grey Cloud Island
Denmark
Afton
Lakeland
Willernie
Mahtomedi
White Bear Lake
Stillwater
Bayport
Lake Elmo
Baytown
Forest Lake
Columbus
Wyoming
Chisago City
Center City
Taylors Falls
Scandia
Marine
Stillwater
Oak Park
Grant
Dellwood
Willernie
Mahtomedi
White Bear Lake
Hugo
Centerville
Lino Lakes
Circle Pines
Blaine
Coon Rapids
Andover
Ramsey
Anoka
Champlin
Rogers
Dayton
Maple Grove
Osseo
Brooklyn Center
Crystal
Robbinsdale
New Hope
Golden Valley
Plymouth
Wayzata
Orono
Medina
Minnetonka
Hopkins
St. Louis Park
Edina
Richfield
Bloomington
Eagan
Burnsville
Apple Valley
Lakeville
Farmington
Hampton
Randolph
Cannon Falls
Red Wing
Welch
Goodhue
Belle Chester
Pepin
Frontenac

proudly: "St. Paul is a healthful town, quite an anomaly at the Mississippi, at least South of us." "It must be added that bilious fevers and the fever and ague are strangers to St. Paul." We have already learned to be somewhat cautious with "guides," gazetteers and newspapermen. There must have been a reason for Dewey and Cavilier to advertise in the same paper Quinine as well as antibilious, cathartic, vegetable and ague pills, Stoughton bitters, etc., and there must have been a reason to inform the readers of the *Minnesota Pioneer* on July 5, 1849, with truly DeKruifish "optimism" about "a new cure of the ague" (with water). It is true, business in patent medicines at St. Paul seems to have been not very flourishing. The advertisements of Graeffenbergs Patent Medicine disappear from the *Minnesotian*, the other St. Paul early newspaper, in 1853.

But we do not need indirect deductions. The memoirs of Knute Steenerson give us a very graphic description of the sufferings from ague among the Norwegian settlers in Looney Valley (a branch of the Root River) in 1853.[5] In 1852 Winona County, at that time called Wabasha Prairie was very sickly with "malarial diseases," yielding readily to quinine; every settler suffered from ague.[6]

It is true, in 1854, Dr. W. W. Mayo came to Minnesota, to get rid of the malaria which plagued him so frightfully in Indiana.[7] Minnesota had undoubtedly the reputation of being a healthy country. But in the light of the above facts this reputation—like that of being particularly wholesome for tuberculosis, circulating at the same time—was rather overworked and such general statements as "there was no malaria in Minnesota in 1853" seem to be somewhat exaggerated.[8]

The *Transactions* of the State Medical Society of 1871 describe a typhoid epidemic in St. Paul in 1870 (p. 55). The *Transactions* of 1872 have still to report intermittents and remittents from three places with one out of five inhabitants being stricken. From four places they report reduction or disappearance of malarial fevers.[9] The "Report on Climatology" in 1879 in the same *Transactions* states that "in the southern portions of the State intermittent, remittent, typhoid, typhomalarial, scarlet fevers, diptheria, etc., have prevailed from its earliest history." "Malaria is confined to the southern parts of the State."[10]

The *First Report* of the State Board of Health (1873) contains the following statement of Dr. D. W. Hand concerning St. Paul:

[5] Steenerson, 1921, p. 133.
[6] *Minnesota Medicine*, 1940, p. 252.
[7] Clapesattle, 1941, p. 28 ff.
[8] *Ibid.*, p. 33.
[9] Transactions, p. 67 ff.
[10] *Ibid.*, p. 125.

Intermittent fever to the surprise of all became epidemic in September [1872], the cases being clear and unmistakable and yielding readily to quinine. Occasionally cases of this disease had been seen here before, but this is the first season it is known to have become epidemic.[11]

Intermittents and remittents are also reported from Red Wing and Goodhue County.[12] Hand, however, claims in the same Report that "the only fever to any extent prevalent in Minnesota is typhoid."[13] In the *Transactions* of the A. M. A. for 1871 Dr. C. N. Hewitt makes the following interesting report:

Paludal poison is reported by our physicians of longest residence as very active in the early settlements of the State, chiefly along the watercourses. Its influence was to induce intermittent and remittent fever, and to give a remittent type to other forms of fever, e. g. enteric fever, taking a form described as typho- or entero-malarial in the valleys along the streams. In the high prairies the pure enteric type is the rule. Intermittent and remittent fever are rare now.

Remittent fever was never epidemic. It is reported endemic at Stillwater, on the St. Croix, and at Wabashaw, at the foot of Lake Pepin; sporadic elsewhere.

Intermittent fever was frequent in the early settlement of the State, both among the Indians and the whites living along the great rivers. It was then of a tertian type. It is now of the quotidian form generally and rare.[14]

The *Second Report* of the State Board of Health (1874) notes that Winona (so sickly 20 years before) is free from intermittent and remittent fevers (p. 97).

In the A. M. A. *Transactions* of 1874 Dr. A. B. Stewart takes up again the question of malaria in Minnesota.[15]

Malarious diseases, away from our large watercourses are almost unknown; and, as a rule do not extend north of Minneapolis, although a few cases have been known as far north as St. Cloud.

During the summer of 1871, fever and ague, and all kindred diseases, prevailed along our large watercourses, but especially those of the Mississippi and Minnesota Rivers.

Usually our summer's heat is not intense enough, nor continuous sufficiently long, to generate paludal poison. Home developed fever and ague is unknown in Duluth, and yet moisture both from marsh lands and soil saturation is in close proximity to the city.

I have been favored with a long letter from Rev. Th. S. Williamson, M. D., a missionary among the Indians [principally the Dakotas] of this State. His labors, commencing at Fort Snelling as early as the year 1835, extended westward to

[11] State Board of Health, I, p. 99.
[12] *Ibid.*, p. 100.
[13] *Ibid.*, p. 31.
[14] Hewitt, 1871, pp. 218, 223.
[15] A. B. Stewart, 1874, pp. 428, 429.

Lac qui Parle, near the western boundary of the State. After residing at Lac qui Parle for several years, he removed to Kaposia, on the Mississippi River near the site of the present city of St. Paul . . .

He says: "Almost every year of my residence in Minnesota I have seen cases of paludal disease, but during my first ten years, only one fatal case. This, like most of the others had its origin in the swamps of the lower Minnesota and Mississippi Rivers." The first cases of typhoid fever bear date with the exceedingly warm summers of 1845 and 1846, with an increase in "quantity and quality" of all paludal diseases; intermittent and remittent fevers frequently following their victims into the winter and in many cases proving fatal.

In the 1875 *Transactions* of the A. M. A., Dr. D. W. Hand continues the reports on malaria in Minnesota:

Over a large portion of Minnesota and Northern Wisconsin, malarial fevers i. e. intermittent and remittent, are unknown; but they do prevail to a limited extent along the banks of the Mississippi River, as far up as Lake Pepin; and after unusually hot dry weather even to the Falls of St. Anthony. When occurring, the intermittent is usually of the quotidian form and not very obstinate. The remittent is mild in form, and yields readily to quinine. Cases of congestive fever are very rare.

Typho-malaria fever in some years, as in 1871 and 1872, has prevailed as a widespread epidemic, and has overshadowed all other diseases . . . That it is not an ordinary remittent fever, is proved by its being unchanged by the use of quinine; by its running a definite course, of about three weeks; and by its epidemic influence, being so frequently turned into typhoid.[16]

The 1885 *Report* of the State Board of Health mentions some malaria in the lake region of southern Minnesota (p. 17).

In 1913 Dr. Sanford in discussing three cases of malaria from Wisconsin and one from Minnesota states that during the last nine years not a single case of malaria has been reported from Minnesota.[17]

There is little doubt that malaria never reached the proportions it acquired in states of the Upper Mississippi Valley located more towards the south. It appears to have been restricted to locations situated along watercourses or lakes and to have been of moderate endemicity. Typhoid seems always to have been much more of a problem than malaria and Minnesota was not spared from the usual confusion between these two diseases. Nevertheless it is possible that the amount of malaria in early Minnesota settlements has been underestimated, perhaps because the high point came prior to the existence of literary and particularly of medical

[16] D. W. Hand, 1875, pp. 374, 375.

[17] Sanford, 1913, p. 83.

sources, and it seems that malaria incidence was considerably higher than during the last 40 years.

Malaria was first observed in the 30's, and appears to have increased in the 50's. Then in the 60's a slow decrease began, interrupted by local epidemics and producing still a fair amount of disease during the 70's, far above the present day level. It seems to have disappeared in the 80's (see Fig. 10). Fig. 11 gives the mortality death rates of the Census.

From the majority of the data it is, of course, also possible to infer a slow increase of malaria during the 50's and 60's and a low peak during the 1870's, which are richest in documentation. But from what has been observed concerning the sudden increase of malaria during the period of intensive settlement in the other states, it is most unlikely that just in Minnesota this period should have been less malarious than the more quiet 70's. The richness of documentation in the 70's is much more naturally explained by cultural improvement in this period than by an increase in malaria.

We do not want to hide the fact that our conclusions differ somewhat from the opinion of the local Health Authorities who think that " malaria has never been a serious problem or any problem at all in Minnesota." Dr. W. A. Riley, the eminent Minnesota malariologist has been kind enough to give a very concise resumé of his point of view (already developed in numerous publications)[18] in a personal communication to us, and we would like to submit to our readers these statements from a most competent source:

> Dr. Thomas S. Roberts, whose medical practice began in the mid-eighties, told me soon after my coming here that there were no reliable data regarding the incidence of malaria since every fever which could not be otherwise classed, was called malaria. I have been impressed by the few earlier references in journals since they seemed much more suggestive of typhoid than of malaria . . .
>
> These experiences confirmed a belief which I have long held that indigenous malaria was not widely prevalent in Minnesota in pioneer days anymore than it has been within the last forty years. The early settlers of Minnesota reached here chiefly after a tedious trip by ox cart or by horse-drawn wagons in the course of which they passed through highly malarious districts even if they did not come directly from such districts. Others came by the slow moving river boats, traversing similar areas. In any case even though they may have originated in non-malarious districts, they were so subject to infection that few could have reached this area without at least the infection in their blood even though they did not have clinical cases of the disease. Under such conditions and under conditions of imperfect

[18] C. G. Riley, 1939, 1940.

diagnosis there would have been plenty to enter into the records of the incidence of malaria if such had been kept. The impression that malaria was widespread would certainly have been gained.

The same condition must be considered in connection with the return of soldiers of the Civil war. In addition it must be considered that the slow river traffic

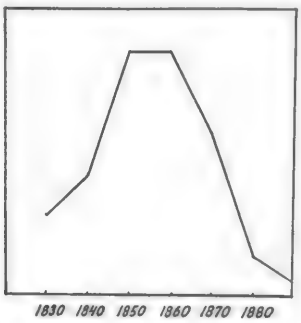

FIG. 10.

MALARIA IN MINNESOTA.

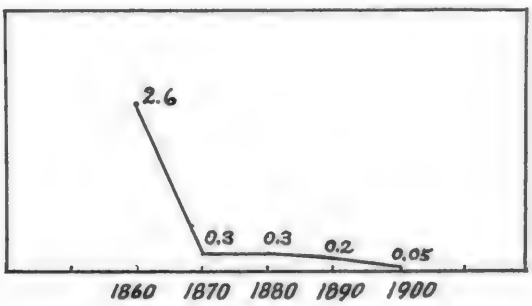

FIG. 11.

MINNESOTA.

Malaria Death Rate in 10,000 Population.

persisted up into the eighties and that not only the boatmen but settlers coming to the State for the first time and residents whose business of whatever nature took them south had ample opportunity to come back with the infection. We have occasional suggestions of the same condition in the case of university students from the deep south or from Central and South America who come down with

malaria soon after entering in the fall of the year. Those cases are rare but must have been very common in pioneer days.

With all of the carriers who must have been present in pioneer days and down to the beginning of the present century the absence of indigenous malaria was due primarily to climatic conditions which did not favor the development of the parasite to the infective stage in mosquitoes, except for brief summer periods particularly in the southeastern part of the state. I expect to see some increase of indigenous malaria with the return of our infected veterans but I am convinced that climatic conditions are such that there can be nothing comparable to a genuine epidemic of malaria in Minnesota. The problem the physicians will face will be those of the soldiers themselves with their relapses.

I think that the first argument of Dr. Riley—the " typhoid " argument—can be partly ruled out, as the observations of our main source Dr. Hand and data from Winona County, insisting on the success of quinine in their malaria cases, establish to a high degree of probability the actual identity of those cases with malaria. To disprove positively the second extremely clever argument of Dr. Riley, that infection generally occurred outside of the state, is of course impossible. Nevertheless it seems doubtful that Minnesotans, always so proud of the healthfulness of their state, should have overlooked the fact or omitted to mention it when " their " malaria was exclusively restricted to recent immigrants, boatmen, and travelling businessmen. The extension and tenacity of endemic foci, as revealed by the material quoted above, is equally not in favor of Dr. Riley's historical thesis, as much as we may agree with his opinions on present day malaria problems in Minnesota. Climatic conditions are undoubtedly unfavorable to malaria in Minnesota; but the experience of Southern Canada and New England shows that under the same isotherms malaria might reach endemic-epidemic proportions during decades.

The Epidemiology of Malaria in the Upper Mississippi Valley as Compared to the Epidemiology of Some Other Regions of the United States

Malaria became highly endemic in Illinois in the 1770's and in Missouri in the 1810's. It held this level with the usual epidemic fluctuations for about 70 years in Illinois, 50 years in Missouri, 30 years in Iowa and Wisconsin, and 20 years in Minnesota, that is, for a shorter period in those states situated more to the north which were settled later. Then it declined and in the 1890's this process was completed (except for Missouri). This epidemiological type which we may call the *Midwestern*

type—as a similar development seems to have taken place in Ohio, Indiana, Michigan, Kansas, etc.,—is exceedingly, we might almost say, dangerously simple. It may offer itself to all kinds of constructions as to the reasons for the disappearance of malaria with which we will deal in the second part of our study. Therefore, before starting this chapter it seems useful if not necessary to remind our readers that even on North American soil malaria has not always and everywhere acted in this Middle Western way. We do not have at our disposal such fascinating and venerable examples as that of the Roman Campagna, where during two and a half millenia malaria four times depopulated the country and four times almost disappeared. But the history of malaria in New England offers us material enough to avoid oversimplifications and to recognize that the Midwestern type of malaria is by no means the only possible epidemiological type even in the northern parts of the United States, and that its history may not yet have come to an end. This *New England type* may not be restricted to New England; it may, for example, also be characteristic for parts of New York State or Virginia. But historical information is so far restricted to New England, owing mainly to the fact that in 1836 Oliver Wendell Holmes, then only 27 years old and still completely unknown, settled down to write as a Boylston Prize Essay what is still the best regional history of malaria thus far written.

Holmes shows that early sources emphasize the healthfulness of the country and that the first reports of the prevalence of fever and ague date only from 1671, 1685 and 1681. The plague of the settlers is already decreasing before 1750 and after 1750 its disappearance is recorded from an increasing number of places. There are even settlements which were never affected. There are, on the other hand, others where a mild endemicity is occasionally transformed into local epidemics, especially in the Housatonic Valley in 1795-1796, Vermont in 1808,[1] and Sheffield in 1828. Holmes' data are confirmed by those of N. Webster who as a general conclusion writes in 1800:

> On the whole we have very clear proof that the quantity of disease has been diminished within half a century . . . The intermittents and remittents of autumn are greatly decreased in the Northern States.[2]

Morse's *Geography* of 1805 says:

> The intermittent fever, or ague, is seldom seen within 30 or 40 miles of the sea coast, and scarcely ever, any where in New England, excepting where they have

[1] Gallup, 1815, p. 55.

[2] Webster, 1800, II, p. 37.

dammed up the water, for the sake of mill streams, that is to say where they have converted a running water into nearly a stagnant pond.[3]

Nathan Smith writes in 1816:

In twenty-eight years practice on the banks of Connecticut River, and on all its tributary streams, in New Hampshire and Vermont, I have never seen a patient sick of the intermitting fever, who contracted it in that region, notwithstanding there are many ponds in that country, both natural and artificial.[4]

When Holmes wrote his essay the disappearance of malaria seemed a *fait accompli*. Bartlett states in 1847, that New England is quite exempt from malaria,[5] and J. F. A. Adams in his extensive study on malaria in Massachusetts states retrospectively in 1880 that from 1800 to 1850 ague was almost unknown as an endemic disease in New England.[6] Yankees as such were recognized by their ignorance of the disease in other parts of the country (see Introduction). But after the Civil War when 52 percent of the White and 83 percent of the colored troops of the North contracted malaria, the disease became again hyperendemic in New England, increasing continuously from 1870 to 1890.[7] Theobald Smith, famous for his discovery of insect transmission in cattle fever (1893), continues in his Shattuck Lecture of 1903 the historic work of Holmes, although he overemphasizes perhaps the role of the Italian immigrants and underestimates the effect of the Civil War in the new malaria wave. (Osler regarded the role of the carriers coming from Italy to New England and Baltimore as insignificant.[8]) T. Smith informs us that in 1890 from 152 cities and towns responding to a circular letter, 86 reported intermittent fever; in 52 the disease was more or less epidemic.[9] Decrease set in only after 1900.[10] Quinn's study in 1926 shows still a certain amount of malaria in southern New England and his data leave it open to doubt whether the favorable conditions of 100 years ago were reached again.[11] Thus in New England we see a picture very different from that of the Middle West: malaria coming and going here twice with epidemic episodes in the interendemic period.

The most important epidemiological type in the United States is, of course, the *Southern type*, comprising those states where malaria is

[3] Morse, 1805, p. 312.
[4] Wilson-Smith, 1816, I, p. 76.
[5] Bartlett, 1847, p. 341.
[6] J. F. A. Adams, 1881, p. 47.
[7] Hoffman, 1918, pp. 77, 79.
[8] Osler, 1917, p. 621.
[9] T. Smith, 1903, p. 43.
[10] Barber, 1930, p. 2.
[11] Quinn, 1926, p. 247.

endemic up to this day, and where considerable decrease started only during this century: thanks largely to economic improvement, to conscious antimalarial measures, and to the knowledge of the malaria-producing organisms and their transmission gained since Laveran's discovery in 1880. Unfortunately, historical knowledge for these regions is, except for the excellent study of Childs on *Malaria and Colonization in the Carolina Low Country 1526-1696*, almost totally absent.

It is most impressive to compare the malaria morbidity of 116,000 for 1914 in Mississippi, as given by von Ezdorf,[12] with the 1932 morbidity of 36,000 as given by Maxcy.[13] Comparison of the data of both authors for Louisiana, Tennessee, Florida, Alabama and Virginia shows similar results. According to Underwood and Whitfield malaria cases in Mississippi decreased from 118,370 in 1920 to 57,709 in 1937, malaria deaths, from 722 to 352.[14] Boyd also emphasizes in 1935 the reduction of malaria in the cities and towns of the *Southeast* "during the last 15 to 18 years."[15] Nevertheless four heavily endemic foci still exist in: (1) Georgia, South Carolina, Florida and Alabama; (2) the Lower Mississippi Valley from Cairo to Natchez; (3) in the "four State" corner of the Red River Valley; (4) at the mouth of the Rio Grande.[16] The sanguine expectations of Bass who announced the disappearance of malaria even in the South within 10 to 20 years have unfortunately not come true.[17] Boyd states in 1941 that malaria reached the lowest level of recession in 1930.[18] Faust in the same year concludes on the basis of mortality statistics that malaria was more widespread and more prevalent in 1940 than it was in the 1930's,[19] and L. L. Williams, Jr., states that malaria after declining from 1912 to 1932, has increased again and is now, although of less intensity and more scattered in its endemic area, still found in the same portions of the same states as in 1912.[20]

There may be still other types (e. g. a "New Jersey-Maryland" type) than the three characterized above, but as research in this respect is lacking and as our study is limited to the Upper Mississippi Valley, we have to be satisfied here with having shown at least two types different from the

[12] von Ezdorf, 1915, p. 15.
[13] McKinley, 1935, p. 12.
[14] Underwood and Whitfield, 1938, p. 103.
[15] McKinley, 1935, p. 378; for the general factors effecting malaria decline in the South, see Boyd, 1930, p. 12.
[16] Faust, 1941, p. 10.
[17] Bass, 1927, p. 13; for similar prospects see Boyd 1930, p. 14.
[18] Boyd, 1941, p. 240.
[19] Faust, 1941, p. 11.
[20] L. L. Williams, 1941, p. 365.

Midwestern type, which, by their very existence, invite caution in too broad generalizations from the Upper Mississippi Valley experience.

We pass now to a phenomenon which is not characteristic of any one of the above-mentioned epidemiological types but may occur in any state, to whatever type it may belong. We call this phenomenon the *epidemiological latency period.* The term epidemiological latency period is chosen to characterize the fact that high endemicity does not immediately follow settlement of a state or locality but is established only after years and decades. We hope to have established this fact for Illinois, Missouri, and to a certain extent, Minnesota. The latency period is brought out very graphically for New England by Holmes. Childs' researches on the colonization of the Lowlands of North Carolina show that in the English colony, founded in 1670, malaria became endemic hardly before 1682 and reached epidemic proportions only in 1684. Whether the Spanish predecessors of the English who attempted colonization since 1526 and failed for other than health reasons, ever suffered to any considerable degree from malaria, seems at least highly doubtful.[21] Michigan is also likely to have had its latency period.[22] Existence of the latency period is controversial for Virginia where Boyd suspects a malaria epidemic as early as 1607 in Jamestown.[23] It is nevertheless significant that Blanton, the medical historian of Virginia, does not think that there is a clear account of the prevalence of malaria in Virginia before 1700—after this date reports become more and more abundant—believing that in the 17th century malaria was at best sporadic and typhoid rather prevalent.[24] Hildreth claimed in 1839 that there was no malaria in Ohio from 1788 to 1807; on the basis of other reports I would regard this statement with the greatest scepticism. But these doubtful cases cannot invalidate either the notion of an epidemiological latency period as such or such clear-cut cases as Illinois or New England. Ross himself seems to have had a similar notion in remarking of Greece (in his Introduction to Jones' book): "It would require, say, half of a century [for malaria] to obtain a firm hold of the country."[25] Drake mentions repeatedly similar local occurrences: Mays Lick, Mason County, Kentucky, was from 1788 to 1806 free from malaria (vol. I p. 255); Chillicothe, Ohio, from 1796 to 1801 (vol. I, p. 294); Gallipolis, Ohio, from 1791 to 1797 (vol. I, p. 291); Pulaski, Pennsyl-

[21] Childs, 1940, pp. 202, 225, 109.
[22] Burr, 1930, I, p. 685.
[23] Boyd, 1930, p. 8; 1941, p. 227.
[24] Blanton, 1931, p. 66; *idem*, 1930, pp. 54-55. See also Scott, I, p. 129.
[25] Jones, 1907, p. 12.

vania, for the first 13 years of its existence (vol. I, p. 283) and Bloomington, Illinois, for 3 years (vol. I, p. 233). In discussing the last named case Drake remarks: "Such instances are not uncommon, though difficult to explain." On the basis of the miasma theory it was difficult indeed.

The existence of the epidemiological latency period in North America seems to me another argument in favor of the hypothesis that malaria was not indigenous in this hemisphere, but post-Columbian and imported by the conquerors as were so many other plagues. Had the Indians been malarious, the first settlers would have fallen immediately victims to malaria epidemics. We cannot insist here on this problem, but we should like to mention at least that, except for Penna and Barbieri (1916), there is an almost general consensus of opinion in favor of the importation theory among those who have ever examined the problem on the basis of sources. One of the most systematic historical and biological contributions in favor of the importation theory is the one of Effertz.[26]

The late Col. Ashburn, the former Director of the Army Medical Library, has left a manuscript on the diseases of pre-Columbian America which he based on the rich sources of this Library and which I had the opportunity to examine thanks to the kindness of Mr. Henry Schuman of New York. Col. Ashburn among many other arguments remarks that an expedition like the one of De Soto in 1541, would have been quickly destroyed had the country De Soto passed through been as malarious as it became in later centuries. Furthermore, it is hardly possible to explain the ignorance of the Indians of the bark—a fact so incongruous with their extensive drug knowledge but testified by LaCondamine, A. v. Humboldt, Ulloa, C. Markham, Pöppig and Spruce[27]—by anything else than their lack of experience with malaria.[28] H. R. Carter who for his history of yellow fever made a very thorough examination of the existing chronicles, likewise concluded that malaria did not exist in America prior to its discovery.[29] Scott gives also numerous instances of South American places today malarious but obviously free from malaria at the time of the conquest.[30] L. L. Williams, Jr., thinks that malaria did not exist prior to White settlement.[31] Boyd leaves the question open.[32]

It seems to me very significant and important that already Benjamin Rush thought that the country was originally healthy and free from the

[26] Effertz, 1909, p. 258.
[27] Suppan, 1931, pp. 30 ff.
[28] Effertz, 1909, p. 261.
[29] H. R. Carter, 1931, p. 69.
[30] Scott, I, p. 128.
[31] L. L. Williams, Jr., 1938, p. 64.
[32] Boyd, 1930, p. 6; 1941, p. 224.

bilious and intermitting fever, which came in only after settlement by the Whites.[33] It has been generally assumed that malaria was imported into this continent by negro slaves. It is strange to see how both the racists, who attribute such an evil act only to inferior people, and the abolitionists, who wanted to prove how God punishes the sin of slavery, agreed on this point. Racial bias also made Theobald Smith see in the unhappy Indian and (with more reason) in the Italian emigrant the reservoir of malaria. As a matter of fact, it will probably be forever impossible to prove which race brought malaria to this continent, but it may safely be stated that in view of the thorough malariazation of the greater part of Europe during the whole period of American colonization up to the 19th century, malaria could probably have been imported and spread on this continent without a single negro ever putting his foot on its shores. The history of the Northern part of the Upper Mississippi Valley where the percentage of negroes was extremely low in the decisive period seems to me to be rather in favor of such an assumption.

It is obvious that with the great regional variations in the development of malaria and in the absence of reliable statistics and sources, it is very difficult, if not impossible, to give a dated general account of the history of malaria in the United States. Among the four authors who have dealt with this subject, Bass and Barber have not even attempted such a dating. L. Williams (1938) places the peak of malaria in the 1870's, its recession in 1912. Boyd, who has dealt with the problem repeatedly and at greater length, thinks that of the three great waves of settlement the first two (the one from the beginnings to the royal prohibition of colonization to the westward of the Alleghenies, and the other from 1812 to 1860) were accompanied by malariazation (Boyd, 1930, p. 7). He places the greatest extension of malaria in the pioneer period (1930, p. 10). Later he has emphasized the influence of the Civil War:

> By the fifties of the past century, the conditions of biological, economic, and social stress which produced the epidemics on the frontiers, were becoming stabilized, and, while malaria had become endemically established over most of the country east of the great plains, it probably existed at a less intense level. This stability was soon broken by the catastrophe of the Civil War, an event which brought thousands of susceptible soldiers of both sides into endemic regions, while the economic ruin of the south produced by the war, maintained conditions favorable to the endemic for many decades.[34]

Boyd thinks that " malaria recession in North America had its beginnings

[33] Benjamin Rush, 1797, p. 268.

[34] Boyd, 1941, p. 233.

perhaps as early as the eighties." [35] From H. I. Bowditch's statement as to the material lessening of malarial fevers everywhere in the United States except in Texas in 1876, one would date the recession even somewhat earlier.[36]

We have already dealt briefly with the latest tendency in discussing malaria in the United States: the tendency to note the reappearance of malaria where it had receded. Boyd gives the following possible reasons for this phenomenon: "(a) the great increase in the number of impoundings of water, either for water power, navigation, sport and recreation, or for esthetic motives and (b) the universality of automobile ownership, which coupled with good highways have greatly stimulated the love for travel and outdoor recreation. The former tends to increase anopheline production, the latter favors the dissemination of infection." [37] In the Upper Mississippi Valley the same fact of reappearance and slight increase had been experienced in the 30's. The 1943 *Report* of the Interstate Malaria Survey, undertaken because of these phenomena, points to the same reasons: increase in traffic and impounded waters (navigation pools, p. 1-2). Thousands of acres have also been swamped again because of cessation of pumping.

The end of the war and the return of infected soldiers will multiply tremendously the number of carriers. But the character of this new chapter in the history of malaria in the United States will probably depend much more on the extent to which social unrest and disorganization will follow the war in this country—thus counteracting plans now already prepared for the prevention of postwar malaria—than on the mere increase in the number of carriers. In any case it may be well to remember that the last war and its aftermath wrote a new and painful chapter in the apparently closed history of malaria in Europe, a chapter which could have been entitled " From Archangel to Sicily."

[35] *Ibid.*, p. 238.
[36] Bowditch, 1877, p. 93.
[37] Boyd, 1941, p. 242. See also L. L. Williams, 1938, p. 67, 79.

POSSIBLE FACTORS FOR THE DISAPPEARANCE OF MALARIA FROM THE UPPER MISSISSIPPI VALLEY

Malaria disappeared from the Upper Mississippi Valley, as from many other places, without the conscious use of antimalarial measures except in some instances quinine treatment, nay, before even the nature of the disease and therefore the possibilities of such measures became known. The causes for its disappearance have therefore to be found elsewhere than in anti-mosquito campaigns, etc. It is besides significant that even for the South, where the constancy of the endemic area would emphasize the rôle of the mosquito in malaria and the importance of such special campaigns—even for this region, Bass, Barber and Boyd, who have been most instrumental and successful in such antimalarial campaigning in the South, agree that the decline of malaria " has a far wider spread than can be credited to special antimalarial operations." [1] The existence of regions where malaria because of the special ecology of *Anopheles* is responsive exclusively to conscious antimalaria measures, as opposed to those where " natural regression " is possible because of a different mosquito ecology, has still to be proved, as it seems that the former never profited from the same economic progress as did the areas of " natural regression."

Nobody has so far been able to attribute this mysterious disappearance of malaria, either in the Upper Mississippi Valley nor anywhere else, to one single factor. What we have are lists of the possible reasons, lists of varying length and composition, and it may be useful to quote first a few such lists for the Upper Mississippi Valley, as prepared by the most competent authorities.

Scott assigns as causes for this development the general advance in civilization, in agriculture and industry, the prophylactic and therapeutic use of quinine, and diffusion of knowledge concerning the rôle of the mosquito.[1a]

C. C. Bass lists as the main agents in the decline of malaria:

1. Cultivation, with clearing and drainage.
2. Screening and increasing knowledge.
3. Quinine treatment.[2]

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[1] Boyd, 1930, p. 12; see also Barber, 1930, p. 12; Bass, 1927, p. 12; Boyd, 1941, p. 238.
[1a] Scott, I, p. 130.
[2] Bass, 1927, pp. 8-10.

Dr. C. F. Jordan, Director of the Division of Preventable Diseases, Des Moines, Iowa, regards as possible factors:

1. Drainage.
2. Education and screening.
3. Relative non-infectiveness of insect vectors as compared with former decades, due possibly in part to:
   a. Gradual decrease in the number of carriers among Civil War veterans.
   b. Decrease in freight and passenger traffic on river steamboats.
   c. Gradual decrease in the number of malaria cases and carriers in the general population.[3]

Barber selects the six following possible factors:

1. Anopheles reduced in numbers by agricultural drainage.
2. Quinine cheaper and more generally used. Medical assistance more generally accessible.
3. Dwellings improved and amount of screening increased.
4. Domestic animals more numerous and stables improved.
5. Parasites have decreased in virulence.
6. The country has become more prosperous. People are better nourished, housed and clothed.[4]

Boyd has given the most extensive and the most concrete lists of the causes for the establishment as well as for the disappearance of malaria in North America:

The introduction of malaria during the colonial period and its subsequent extension along the frontier were probably facilitated by the operation of the following factors:

1. The existence of an indigenous anopheline mosquito (quadrimaculatus) which had already acquired the habit of searching out human beings as a source of food. . . .
2. The greater density of the white population as compared with the aboriginal.
3. The location of settlements along the natural channels of communications (i. e. the watercourses) resulting in the frequenting of anopheline production areas by the early settlers. Similarly, the early agriculturists first broke up the lands close to the streams.
4. The beginning and continuance of the slave trade, which resulted in continuous though forced immigration from highly endemic regions.
5. Haphazard clearing, which exposed many hitherto shaded pools or depressions to sunlight, and thus provided new and acceptable breeding places for quadrimaculatus . . .
6. The damming of small water courses to afford local water power. The

[3] Letter Dr. Jordan, Aug. 13, 1943. [4] Barber, 1930, p. 5.

resulting ponds were numerous as the small radius of convenient transportation by horseback tended to promote their multiplication.

7. The assembling of immigrants from many different sources in any area, resulting in the mingling of chronic malaria sufferers from the seaboard with susceptibles from the North and from Europe. The slow character of available means of travel, requiring nightly halts afforded numerous opportunities in various situations to disseminate and contract infection.
8. The flimsy structures first erected as habitations which afforded no impediment to the entrance of anophelines.
9. The small amount of livestock brought by the early settlers. These animals . . . turned loose to forage for a living . . . afforded little opportunity for the diversion of anophelines from the human host.
10. A low standard of nutrition.
11. Inadequate and improper treatment.[5]

The following social and economic changes appear to have participated in the decline of malaria in the States to the north of the Ohio River:

1. The westward wave of immigration left in its wake a fixed population, in which, as individual families gained an economic independence, there was a gradual disappearance of the privations and hardships of pioneer life. Framed houses were substituted for log cabins, and, after farms were cleared and drained, a higher standard of living prevailed as markets became available for farm produce.
2. The introduction and extension of railroads resulted in the gradual decline in the importance of water courses as routes of communication. Travellers supported the innovation, which economized time and removed them from the haunts of anophelines in the river bottoms. The hotels in the larger cities became points where journeys were interrupted instead of the small isolated rural inns.
3. As settlement progressed, this region was characterized by the progression of agriculture from the bottom lands to the uplands—a change closely associated with the extension of the railroads. In some regions, as the glaciated portions of Ohio and Iowa, this brought the settlers into contact with the prairie ponds, potential places for quadrimaculatus production. The drainage of these, to recover this land for agricultural use, was however effected only in the course of half a century or more.
4. The opportunities for gain from agriculture stimulated the cultivation of all land that can be profitably utilized. In this connection upland drainage has been the effect rather than the cause of the intensification of agriculture. In its turn intensification promotes methods of agriculture that conserve the productivity of the soil, and hence promotes animal husbandry. Thus waste land on which anopheline breeding can occur unhindered, is diminished in extent, and cattle which are kept confined, increase in number, and tend to divert the residual anophelines from man.

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[5] Boyd, 1930, p. 9.

5. As population has increased, the dwellings in cities and towns have largely receded from the river and stream terraces that are annually inundated . . .

Another factor not previously mentioned, and which has been in operation over the whole country for a longer period, was the improvement in therapy, effected by the substitution of quinine for cinchona bark.[6]

I have thought it worth while not to limit my efforts of explanation to the establishment of another list of possible factors, but to examine in more detail the points which seemed to me most important in the foregoing lists. I tried to date the appearance of these factors, to establish if possible their quantitative importance, and to see whether any particular connection between one or several factors and the epidemiological curve could be established. I soon realized that this was a rather ambitious enterprise, and almost doomed from the beginning by the lack of reliable and sufficiently detailed data on most of the single factors. I have felt how mechanical it was to separate fundamentally interdependent factors, an interdependence so well characterized by Barber:

It is evident that these factors are more or less cooperative; as one rises or falls it tends to pull the others with it. The relative efficiency of a factor or group of factors may vary with locality and circumstances, and all are dependent on the agricultural development of the country.

The economic factor may include all of the others.[7]

But I regard it as a scientific duty to continue with the analysis of malaria decrease in a given region by weighing the several factors as was tried first by Barber even when the prospects of success are not very bright. I have chosen for examination the following 12 points:

1. Population movement.
2. Railroad, steamship and steam regulation.
3. Clearing, cultivation and drainage.
4. Prosperity.
5. Housing.
6. Screening.
7. Education.
8. Food.
9. Cattle breeding.
10. Mosquitoes.
11. Quinine.
12. Weather and climate.

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[6] *Ibid.*, pp. 10 ff.

[7] Barber, 1930, p. 5, p. 10.

I am fully aware that this list looks odd as a program for a medical enquiry, most of its elements being of a social nature, some of them being even irrelevant to the problem of anopheline transmission proper. But this is not due to personal bias; I do not belong to any school which thinks of malaria as a purely social disease, as opposed to one which thinks of it as a purely local question of parasitism (if, as Hackett claims, such schools should exist, I would consider them both rather one-sided).[8] I sincerely think that the choice of factors is dictated to us, as it would be to everybody else, by the Janus-like, double-faced nature of malaria itself which prompted the ingenious anonymous book reviewer of the *American Quarterly Review* of animalcula fame to state that every book on malaria is also a book on political economy. Although this is fundamentally true of every disease, it is particularly true for malaria, where economic factors are so closely interwoven with the possibilities of anopheline transmission, that any study of malaria has to include the study of such social phenomena. It seems to be more than mere coincidence that malaria disappears from New England just when, as the historians inform us, a certain state of sociocultural balance and maturity is reached towards the end of the colonial period. And it is perhaps more than mere coincidence that the disappearance of malaria in the Middle West is so close in time to the fateful date of the end of the frontier in the 1890's. " It is plain how closely the prevalence of malaria was associated with pioneer life and its decrease with the agricultural development of the country " (Barber, 1930, p. 9).

To a certain extent our attitude is also dictated by the nature of the material available to the historian. While even under frontier conditions man cannot help leaving at least a few records concerning the basic socio-economic facts of his life, no such records are available concerning biological facts, in our case concerning mosquitoes and plasmodia. And no good will of the historian, no theoretical preparedness to deal preponderantly with biological facts, and no admiration for those who like Hackett have so successfully followed the latter way, can replace such missing records.

Population Movements

That invading armies provoke an increase in malaria and are its first victims is well known from the War of Independence as well as from the Civil War; from World War I as well as from World War II. But that,

[8] Hackett, 1937, p. 16.

in so far as malaria is concerned, an army is only a model case of a massive influx of population, is less realized. Especially if it is an " army " of colonizing settlers or pioneers, similar to an invading force but sometimes even in a worse position. Childs has rightly emphasized in his study on the Lowlands of Carolina that colonization is most conducive to the propagation of malaria, much more so than e. g. nomadism or individual mobility.[1] Concerning the relations of malaria and the moving of populations the Malaria Commission of the League of Nations states:

> Nothing is more favorable to a high incidence and severity of malaria than frequent movements of a population hither and thither in search of a bare living or of a place where the conditions of life are less hard; and very few things have a greater effect in reducing malaria than the stability of the population which comes when such a place is found.[2]

That such population movements influence the malaria morbidity, was sometimes empirically realized even in the period and region here under examination. Reyburn e. g. states that in 1852 there were more periodics in St. Louis than in 1851 and brings this phenomenon himself in relation to a 30 per cent increase of foreign immigration in 1852.[3]

We understand better today why migration has this particular effect. Not only are the incoming masses of non-immunes " fuel " for the already endemic strain, not only do the parasites of incoming carriers prey on the non-immunes, but, as immunization seems strain-specific, the old acclimatized population is also stricken again by the new incoming strains.

On these factors are also based the particular risks of travel to the non-immune and the special danger of the carrier-traveler to the community he visits. Drake drew attention to the malaria hazard involved in traveling, especially in autumn, in an article in the *Western Medical and Physical Journal*, vol. I, no. 6. He gave as an example a female emigrant who after ten years of undisturbed health succumbed to bilious remittent fever as a consequence of a journey in September. He did not mention that the lady was his own wife whom he had loved and did love to his very end with an ardor and tenderness hardly suspected with this rough fighter and pedantic compiler.[4]

Fascination with the mosquito has grown sometimes to such heights that the human factor in the malaria equation, the elementary truth: " There could be no malaria, even in a mosquito ridden population without

[1] Childs, 1940, p. 19.
[2] Malaria Commission, 1927, p. 27.
[3] Reyburn, 1855, p. 160.
[4] Mansfield, 1855, p. 178.

the presence or introduction of human carriers," has been almost completely overlooked.[5]

Theobald Smith stressed vainly a very important point when he emphasized in 1903 that much more important than drainage for the reduction of malaria in the Middle West was the absence of new carriers living in crowded conditions with non-immunes.[6] He pointed out that the isolated carrier is relatively harmless, but that a congested intermingling of carriers and non-immunes makes for a tremendous increase in malaria. He argued on the basis of railroad and canal building gangs. But the crowded and always hospitable log cabin harbored a not less explosive mixture of humans, mosquitoes and parasites.

The migratory character of the 19th century American impressed foreigners like Marryat, Hall and C. A. Murray deeply.[7] But even Americans were struck by the phenomenon.[8] Between 1830 and 1860 the Upper Mississippi Valley seems to have attracted most of the immigrating settlers, experiencing its greatest population increase between 1850 and 1860.[9] Dan E. Clark says of the westward movements in the Upper Mississippi Valley that such an increase in population was without a parallel up to that time, and that for the first time foreign immigrants participated in numbers.[10] Annual foreign immigration into the United States rose from less than 100,000 in 1844 to more than 400,000 in 1855.[11] A great migration wave rolled west after the crisis of 1837,[12] and the high tide seems to have been reached in the years immediately preceeding the panic of 1857.[13] In 1860 the population increase rate shifts farther west.[14]

Illinois experienced several particularly high waves of immigration in 1795, in the 1810's, 1830's and 1850's, Missouri in the 30's and 50's.[15] The rush into Iowa occurred mainly in the 50's (1854-1856), partly as a consequence of railroad construction.[16] Nathan Parker offers an impressive collection of contemporary descriptions of the immense immigration into Iowa in 1854.[17] A rapid movement into Wisconsin and Minnesota took place also in the 50's.[18] It is significant that all these "invasion periods" coincide with malaria heights in the respective states.

[5] Garrison, 1929, p. 888.
[6] T. Smith, 1903, pp. 47, 51.
[7] W. J. Petersen, 1934, p. 316.
[8] C. C. Andrews, 1857, p. 165.
[9] Petersen, 1934, p. 314.
[10] Schmidt-Ross, 1928, p. 14.
[11] Sakolski, 1936, p. 100.
[12] J. T. Adams, 1939, p. 214.
[13] Petersen, 1934, p. 351.
[14] Sakolski, 1936, p. 93.
[15] Petersen, 1934, p. 322.
[16] Schmidt-Ross, 1928, p. 149.
[17] N. Parker, 1856, p. 54 ff.
[18] Petersen, 1934, p. 327; C. C. Andrews, 1857, p. 165.

The statistics at our disposal give of course a very imperfect basis for orientation in our subject matter, as we are not only interested in absolute numbers but also in the process of movement; two identical numbers (1,000,000 population in the year "X" and 1,000,000 population in the year "Y") may hide an intensive and for malaria highly significant population movement where the end results are only equal because the influx has compensated the loss. From Thornthwaite, who is one of the very few to have attempted statistics of population movement, we learn that net loss of population was first experienced by Wisconsin and Illinois in the decade 1860-1870. Population deficit (more people born in a state leave it than people born in other states enter) was observed first in Wisconsin in 1890, in Iowa and Missouri in 1910, in Minnesota in 1930. Thornthwaite has formulated the following rule: "About three decades after the first settlement the population surplus reaches a maximum and after about three more decades of decreasing surplus a deficit is established." [19]

In the 1840's another significant trend in population movement starts: farm machinery sets rural population free for the cities where the factory system becomes more and more dominant.[20] By this new tendency a number of rural or immigrant carriers are absorbed and neutralized by the Anopheles-free big cities, and the flux of non-immune masses towards endemic areas comes to a stand-still. While this tendency, ripening rather late in the United States, undoubtedly played a great rôle in the decline of malaria in Europe, it is difficult to say to what extent it influenced the development in the Upper Mississippi Valley.

Thornthwaite's statistical findings and criteria are in no relation whatsoever to the epidemiology of malaria as we have tried to reconstruct it from non-quantitative sources.

The data of population increase in absolute numbers and percentages as given in Table No. 1, show in Missouri, Iowa and Wisconsin a remarkable coincidence between the supposed decade of malaria decrease and a first sharp drop in the percentages of increase in population. Missouri: supposed malaria decrease during the 70's, drop of population increase from 45.6 percent in the 60's to 26.0 percent in the 70's. Iowa: supposed malaria decrease in the 70's, drop of population increase from 76.9 percent in the 60's to 36.1 percent in the 70's. Wisconsin: supposed malaria decrease in the 60's, drop of population increase from 154.1 percent in the 50's to 35.9 percent in the 60's. But the fact that neither Illinois nor Minnesota shows

[19] Thornthwaite, 1934, p. 10.

[20] Sakolski, 1936.

TABLE 1

Population Increase

	ILLINOIS		MISSOURI		IOWA		WISCONSIN		MINNESOTA	
	Total Population	Percentage of Increase	Total Population	Percentage of Increase	Total Population	Percentage of Increase	Total Population	Percentage of Increase	Total Population	Percentage of Increase
1810	12,282		20,845							
1820	55,211	349.5	66,586	219.4						
1830	157,445	185.2	140,455	110.9						
1840	476,183	202.4	383,702	173.2	43,112		30,945			
1850	851,470	78.8	682,044	77.8	192,214	345.8	305,391	886.9	6,077	
1860	1,711,951	101.1	1,182,012	73.3	674,913	251.1	775,881	154.1	172,023	2730.7
1870	2,539,891	48.4	1,721,295	45.6	1,194,020	76.9	1,054,670	35.9	439,706	155.6
1880	3,077,871	21.2	2,168,380	26.0	1,624,615	36.1	1,315,497	24.7	780,773	77.6
1890	3,826,352	24.3	2,679,184	23.6	1,912,297	17.7	1,693,330	28.2	1,310,283	66.7
1900	4,821,550	26.0	3,106,665	16.0	2,231,853	17.7	2,069,042	22.2	1,751,394	33.7

the phenomenon is reason enough not to overemphasize the importance of these statistical relations. It could, of course, be argued that Minnesota because of its northern location is an exception anyway, and that the Illinois population increase during the 50's is largely urban and thus of minor importance for malaria. But such arguments seem somewhat artificial. It is more likely that such crude statistics cannot be supposed to yield more detailed rules of general validity.

I think that in spite of the doubtful importance of a particular statistical observation (relation between drop in population increase and decrease of malaria), the publication of the data on population increase in the Upper Mississippi Valley is nevertheless justified, as to the attentive reader they convey the whole story of the truly gigantic and unique population increase in the Upper Mississippi Valley, particularly between 1830 and 1860. They witness that " frequent movements of a population hither and thither in search of a bare living or in search of a place where the conditions of life are less hard . . . favorable to a high incidence and severity of malaria " were realized in the Upper Mississippi Valley to a degree seldom observed in any other region or period; and that in a general way the stopping of these mass movements coincides with the disappearance of malaria from the Upper Valley.

Steamships, Railroads, River Regulation

While the gigantic population movement was a first cause in the spread of malaria and the stabilization of this movement one of the main factors in its decline, the means by which the army of settlers traveled and which brought and kept it in closest contact with the *Anopheles* for decades were hardly of minor importance. The ways, both for men and goods, were predominantly the waterways and the innumerable streams and rivers of the great Valley of the Interior. This is what made the possession of the Mississippi estuary such an important political question in the beginning of the 19th century. People may have realized the health hazards of river traffic already in the 1820's, as seems evident from the notes of James Flint.[1] Even female travelers observed the wretched appearance of the woodcutters along the rivers.[2] But good land roads could not be improvised in a wilderness, while the paths of the rivers were not only ready, but much more speedy than any possible land road since the steamship had replaced the flat boat. Only the railroad could dethrone the steamship and

[1] J. Flint, 1822, p. 164.

[2] Trollope, 1832, I, p. 27.

thus help change the whole economic and epidemiological situation. Slow land travel on wagons through a thoroughly malaria-infested region was as much of a health hazard as traveling the river.

But people not only traveled and shipped their products on the rivers, they also settled along these liquid roads—" les chemins qui marchent " of Pascal—as they have always done. And this, of course, far more than the mere traveling, perpetuated the malaria danger and infestation. It is interesting that even in the most advanced of the five states, Illinois, few people settled at any distance from rivers before 1850.[2a] Dr. MacClintock of Iowa was kind enough to show me a very accurate map of Iowa by Olshausen, printed in 1855 in Kiel, which brings out very graphically that settlement in Iowa was at that time restricted to the land along the river courses. The same holds good for the other states.

Steamboat travel on the Upper Mississippi started relatively early. In 1823 the first steamboat seems to have gone up to St. Paul. But travel by steamer seems to have become intensive only in the 40's,[3] reaching its climax between 1857 and 1860, when it became involved in a fiery competition with the rising railroad. The Civil War paralyzed and broke it as the leading factor of communication. Its decline seems to have been accomplished in the 70's,[4] although Dr. Riley in his letter quoted above still speaks of its persistence for Minnesota in the 80's. Being occupied here exclusively with the bare data of Mississippi steamboating and its impact on malaria, we unfortunately cannot dwell on many other aspects which have formed the subject of the charming memoirs of Mark Twain, G. B. Merrick and others, and of the fascinating scholarly research of Prof. W. J. Petersen.

Railroad building and operation in the Upper Mississippi Valley began on a large scale around 1850 after many local attempts and failures. The fact that between 1849 and 1860 30,000 miles of railroad were built in the Northwest was of tremendous strategic and political importance in the Civil War.[5] According to the Census the following railroad mileage was built in Illinois, Missouri, Iowa, Wisconsin and Minnesota:

1840-1849:	97 miles
1850-1859:	4607 miles
1860-1869	4410 miles
1870-1879:	13331 miles
1880-1890:	74100 miles

[2a] Church, 1931, p. 88.
[3] C. C. Andrews, 1857, p. 167.
[4] P. W. Brown, 1918; W. J. Petersen, 1937.
[5] J. T. Adams, 1939, p. 245.

The greatest number of miles in a single year was built in 1871. In Illinois railroad building started in 1833-35, and in 1856 this state had more railroads than Iowa, Wisconsin and Michigan together. James Laird wrote of Illinois in 1859 in his *Prairie Farming in America* (New York, 1859): "Illinois is a state traversed by a most perfect system of railroads where no settler need be more than ten miles from a station." The first rails in Wisconsin were laid in 1851. The first railroad in Iowa (from Davenport to Iowa City) was started in 1855 but the general covering of the state with railroads made slow progress. We may thus suppose that the railroad was an important competitor of the steamboat in Illinois around 1855, in Missouri around 1860, in Iowa in 1865, in Wisconsin in 1860 and in Minnesota around 1865. The effectiveness of the early railroads in liberating the settler from the necessity of river traffic and river location was sometimes seriously limited by the exorbitant prices and freight charges of the railroad companies. These abuses were eliminated in the 70's, when Illinois, Iowa, Wisconsin, Minnesota, Missouri, Nebraska and California, under the pressure of a great, popular farmer movement, promulgated the famous "railroad laws."

While the railroad in the long run was an important factor in the elimination of malaria, locally and temporarily it sometimes led to an increase of malaria. Railroad gangs (like the canal gangs in the 30's) suffered heavily from malaria and spread it. Railroad ditches or the blocking of natural drainage by railroads dams created new breeding places. The malaria thus originating is one of the outstanding examples of what H. R. Carter called "man-made malaria." The phenomenon was, of course, well understood after Ross' discovery of the transmission mechanism in 1898, widely discussed in the first antimalaria conferences by public health engineers, and largely eliminated with the collaboration of the railroads;[6] although Hackett still warns:

> Until construction engineers develop a conscience with regard to malaria, they must be regarded by the health officer as one of the most dangerous and difficult of his malaria hazards.[7]

It is very much to the honor of the medical profession that doctors, even before the fact could be understood, empirically discovered its importance and claimed improvements. Dr. J. J. M. Angear of Iowa asks in 1874 that the companies be obliged to drain and fill the ditches.[8] Dr. J. D.

[6] Stromquist, 1921, p. 91.
[7] Hackett, 1937, p. 276.
[8] Angear, 1874, p. 395.

Airey of Evergreen, Ala., dealt with the question very thoroughly in the *St. Louis Med. Surg. Journal* as early as 1872.[9]

The river was so instrumental in propagating malaria by numerous floods which left innumerable breeding places in the form of shallow ponds that Drake prophesied that the Valley would be healthy once the stream was regulated.[10] But for two reasons stream regulation seems to have played a minor role in the disappearance of malaria from the Upper Mississippi Valley: floods are not so numerous and extensive in the Upper as they are in the Lower Valley; and stream regulation actually occurred so late that it is unlikely it influenced deeply the decline of malaria in the Upper Valley. Dr. H. A. Whittaker, Director of Sanitation, Department of Health, Minneapolis, Minnesota, has been good enough to give me the following data on the reservoirs at the headwaters of the Mississippi which present the main instrument for the regulation of stream flow. The following reservoirs were put into operation during the years indicated:

Leech Lake	1884
Lake Winnibigoshish	1884
Pokegama Lake	1884
Sandy Lake	1895
Pine Lake	1886
Gull Lake	1912

A Mississippi River Commission was installed in 1879, but actual improvements under a Federal Board of Engineers for Rivers and Harbors seem to have begun only in 1902. That local damming in stopping minor floods could sometimes be of good effect we know from occasional statements as the one of Dr. Angear.[11] But we have no possibility of estimating its quantitative importance.

While river control appears to have been unimportant for the decline of malaria in the Upper Valley, it contains potentialities for a new increase in having created new breeding places for anophelines. We have already quoted the observations of Boyd and the Interstate Malaria Survey concerning this subject. Faust writes in 1941:

> Along the Upper Mississippi and Missouri Rivers endemic foci or sporadic outbreaks of malaria have been reported recently, which are associated in part with impounded water projects to provide better navigation facilities and for flood control.[12]

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[9] Airey, 1872.
[10] Drake, I, p. 137.
[11] Angear, 1874, p. 395.
[12] Faust, 1941, p. 140.

Clearing, Cultivation and Drainage

Railroad ditches and navigation pools are only some of the last examples of "man-made" malaria and they are relatively limited in importance compared to other complexes of this kind of malaria. As a matter of fact it seems that most malaria is "man-made" because certain agricultural habits of settlers in anopheline countries are apt to create new breeding places for anopheles and therefore to produce malaria.

Benjamin Rush in his extremely interesting *Inquiry into the Causes of the Increase of Bilious and Intermitting Fever* (1785) enumerates as causes of such an increase, (1) establishment of mill ponds, (2) clearing and (3) the combination of wet springs and dry summers. Two of the three factors are obviously man-made. Rush shows his mastership of observation and clear thinking in establishing the following differentiation between clearing and cultivation:

> I beg a distinction to be made here between *clearing* and *cultivating* a country. While clearing a country makes it sickly, in the manner that has been mentioned, *cultivating* a country, that is draining swamps, destroying weeds, burning brush, and exhaling the wholesome and superfluous moisture of the earth, by means of frequent crops of grain, grasses and vegetables of all kinds, render it healthy.[1]

In this article as in his *Inquiry into the Various Sources of Autumnal Diseases* he draws attention to the fact, that in the swamps of North Carolina and Delaware families live healthy lives, but suffer from fevers as soon as clearing starts.[2]

Rush's observations were repeatedly confirmed in later years. J. Mann writes in 1816:

> A country, in a state of nature, previous to openings for cultivation, is less subject to diseases than the same district after improvements are commenced by the agriculturist. Hunters and surveyors of the woodlands, exposed during many months to all the vicissitudes of weather, with little or no shelters from cold storms, seldom suffer from diseases. The aborigines experience fewer diseases than the inhabitants of new settled countries . . . In proportion as cultivation is extended . . . endemics disappear." [3]

The anonymous contributor to the *American Quarterly* of 1828, already mentioned as promoter of the animalcular hypothesis of malaria, tells of malaria epidemics among the settlers in the Genesee Valley, 1796-1800, and in the Shenandoah Valley from Winchester through Carlisle and

[1] Rush, 1797, p. 268.
[2] Rush, 1805, p. 215.
[3] Mann, 1816, p. 109.

Easton in 1804 which arose from their clearing the rich bottom lands.[4] Dr. Yandell writes in 1841:

> Along our streams disease is known to have become much more prevalent, since the shrubs and trees, fringing their borders were cleared away.[5]

Forry states in the *Medical Statistics* of the U. S. Army in 1840:

> It is a well known fact that military stations, near jungles, often continue healthy until the soil is brought under cultivation, or the trees and shrubbery cut down, exposing the boggy surface to the agency of solar action.[6]

And in his *Statistical Researches Elucidating the Climate of the United States*:

> In Canada and the U. S. it is a fact well known from their earliest history that although cultivation renders a climate more salubrious, yet its endemic diseases for several years after the soil is cleared from its more bulky vegetable productions often become more severe than previously and not infrequently assume an epidemic character . . . The soldier, the hunter and the wild borderer suffer less from disease than the actual settler.[7]

We find, of course, similar statements in Drake,[8] and we have quoted already the observations of Drs. Henry (1851) and Field (1867) of Iowa in the chapter on this state concerning the same phenomenon. The *Anopheles quadrimaculatus*, our main transmitter, dislikes dense shade. Therefore the lumberman often creates good breeding places. And consequently the timberlands of Iowa were regarded as more salubrious than either prairie or bottom lands.[9]

It is most likely that here we may have the explanation for the mysterious healthiness of the early French settlers. In so far as they were traders and hunters they did hardly any clearing, and where they became agriculturists they were living in compact villages and laboring in common fields.[9a] This made for far fewer breeding places than the isolated farms of the American settlers, with their surplus of cleared land as compared to the land which could actually be cultivated.

The evil consequences of the erection of dams for mill ponds are not only stated by Rush, but also emphasized by Holmes [10] and Wroth.[11]

The most effective, or at any rate the most obvious element in overcoming the evil consequences of clearing is *drainage*. In the beginning

[4] P. 292; see also Parsons, 1839, p. 206.
[5] Yandell, 1841, p. 167.
[6] U. S. Army, 1840, p. 295.
[7] Forry, 1841, p. 45.
[8] Drake, II, p. 24.
[9] Henry, 1851, p. 301.
[9a] Violette, 1918.
[10] Holmes, 1838, pp. 48, 56.
[11] Wroth, 1842, p. XXII, p. 39.

drainage was in our culture, and in most parts of the world still is, the classic example of what Garrison called " the attainment of a sanitary end without definite sanitary intention (immanent or intuitive sanitation of Sudhoff)." [12] But the sanitary effect that drainage exerts, besides having an agricultural one, seems to have been recognized as early as the Greeks and Romans. Since that time, drainage has been widely recommended, although a true insight into its action was possible only after the discovery of the mosquito transmission of malaria, the disappearance of which from many countries has been repeatedly explained in terms of drainage.

It is impossible to give here more than a few examples on the history of drainage from the period and the region now under examination. Rush, in his 1785 essay, gives a list of preventive measures against malaria, a list based on experience and containing, besides truisms on cleanliness, proper diet and clothes, such excellent advice as the burning of fires and avoiding of the evening air. But his first rule is: " Let the cultivation [that is draining, ploughing, sowing, E. A.] always keep pace with the clearing of our lands." [13] In 1806 he writes again in his *Information* to prospective immigrants:

> It has been remarked in this country, that clearing the land of its *woods*, sometimes makes a new settlement unhealthy . . . To obviate this evil, it will be necessary for the settler either to drain and cultivate his low grounds, as soon as they are cleared, or to leave a body of trees between his dwelling house, and the spots from where the morbid effluvia are derived.[14]

N. Webster states in 1800:

> There are two modes of rendering marshy lands and stagnating water salubrious—one, by draining the lands and cultivating them; the other by turning into them streams of running water.[15]

Webster also recommends building at a distance of one mile from marshes, an empirical advice which coincides fairly well with the flight range of most anophelines.[16] Caldwell in 1831 advocates cultivation and drainage on the basis of favorable results already obtained.[17] Dr. Ira N. Barns reports the favorable effect of cultivation on malaria in Decatur, Illinois, during the 30's.[18] The English physician Dr. J. S. Meldon describes malaria in Eldridge village, Edgar County, Illinois, in the 40's and notes

[12] Garrison, 1929, p. 889.
[13] Rush, 1797, p. 272.
[14] Rush, 1806, p. 194.
[15] Webster, II, p. 366.
[16] *Ibid.*, p. 369.
[17] *Am. J. Med. Sc.*, VIII (1831), p. 294.
[18] Zeuch, p. 453.

the good effects of drainage.[19] Drake refers repeatedly to the positive effects of drainage e. g. for Shawneetown after 1838.[20] Ketchum notices the lower incidence of malaria in Mobile after the filling of morasses and installation of better drainage in 1843.[21] Gruel in 1868 mentions positive effects of drainage in overcoming the endemicity of the Mississippi Valley.[22] Dr. Angear emphasizes the combined effect of drainage and building a dam and grazing cattle on the decrease of malaria in Lee County, Iowa.[23] Joseph Wilson, Medical Director of the U. S. Navy, recommends underdrainage, as it has been done in England to get rid of the chills (he also recommends living on ships in the Chinese fashion).[24] Dr. S. P. Bread reports on the salutary side effect of extensive county-financed agricultural drainage in Illinois in the early 70's. In similar terms Dr. J. H. Beech describes the consequences of the 1867 and 1871 drainage laws in Michigan.[25] G. Sternberg, later Surgeon General, in 1884 heads his list of prophylactic measures with " thorough drainage and cultivation," continuing then with forestation; flooding of swamps which cannot be reclaimed; smoke and quinine.[26] The 1901 *Report* of the Missouri State Board of Health reports the favorable effect of drainage in St. Clair County (p. 79). In his *Historical Sketch* of 1941 Boyd attributes to agricultural drainage the principal rôle in the recession of malaria north of the Ohio River. He says " It will be noted that Ohio and Michigan made considerable progress prior to 1870, with Indiana trailing while little was done in Illinois and Iowa prior to 1880, and the alluvial lands of the lower Mississippi were largely neglected until after the turn of the century." [27]

When I submitted the problem of disappearance of malaria from the Upper Mississippi Valley to several public health authorities, some came out strongly in favor of drainage as the essential factor, e. g. Dr. Roland R. Cross, Director of Public Health, Illinois, who wrote:

> My opinion is that the most important factor in the decline of malaria in Illinois was the development of agriculture and particularly the drainage system which was developed as a part of agricultural interests.

Prof. T. LeBlanc, Cincinnati, brings drainage, clearing, and deforestation under one heading in the following remark:

[19] *Ibid.*, p. 378.
[20] Drake, I, p. 317.
[21] In Fenner, 1851, p. 303.
[22] Gruel, 1868, p. 4.
[23] Angear, 1874, p. 395.
[24] Wilson, 1876, pp. 378-379.
[25] Bowditch, 1877, pp. 159, 177.
[26] Sternberg, 1884, p. 119.
[27] Boyd, 1941, p. 238.

The major influence was the decrease in standing water, no matter what brought about this decrease. Also anything that decreased the 'holding power' of the soil tended to decrease the accumulated moisture. Thus clearing of land for farming, draining of lands, deforestation, clearing of brush and all the various activities involved in turning land from virgin land to farm land . . . all contributed to the decrease in the mosquito and probably is the main reason for the decrease in malaria.

We pass now from theories and local data on the relation of malaria and drainage to the not overly numerous data on the history of drainage in the Upper Mississippi Valley which we have collected.

The first census of drainage in the United States (published as vol. VII of the XIV Census of the U. S. taken in 1920, Washington, 1922) makes (p. 353) a statement as to the character of the region we are concerned with which explains a great deal of its malaria history: The East North Central Section (Ohio, Indiana, *Illinois*, Michigan, *Wisconsin*) contains the greatest portion of land in the United States needing or having artificial drainage. The second largest portion is the West North Central Division (*Minnesota, Iowa, Missouri*, North Dakota, South Dakota, Nebraska, Kansas). This agrees perfectly well with the statement of Prof. E. W. Lehmann, Head of the Department of Agricultural Engineering, Urbana, Illinois:

Much of our best farm land in the Middle West has been artificially drained. This is particularly true of this section of Illinois, the north central section of Indiana and the northern section of Iowa. Many drainage ditches were constructed in this prairie country some fifty or more years ago which made this land suitable for cultivation here in Illinois.[28]

As to the character of great parts of the country previous to drainage Prof. Lehmann, in a paper read at the 50th Anniversary Meeting of the Illinois Society of Engineers, Jan. 31, 1936, gives a very impressive quotation from W. H. Keating's *Long's Expedition to the Source of St. Peter's River in 1823:*

From Chicago to the place where we forded the Des Plaines, the country presents a low, flat, swampy prairie, very thickly covered with high grass, aquatic plants and among others, the wild rice. The latter occurs principally in the places which are still under water, its blades floating on the surface of the fluid like those of the young domestic plant. The whole of this tract is overflowed during the spring, and canoes pass in every direction across the prairie.

Nobody who has ever traveled in spring in these regions, even today after the extensive drainage, has any doubt concerning the truthfulness of these statements and the essentially "wet" character of the region. In Table 2 we have collected from the Census of 1920 (pp. 352, 377) data

TABLE 2

Results of Drainage Executed between 1870-1919

	Illinois	Missouri	Iowa	Wisconsin	Minnesota
All farms	237,181	236,004	213,439	189,285	178,478
Farms provided with drainage	99,246	11,917	88,865	21,838	53,011
Percentage	41.8	14.5	41.6	11.5	29.7
Farms needing drainage	33,731	19,572	56,083	52,228	73,905
Percentage	14.2	7.4	26.3	27.6	41.4
All land, acres	31,974	34,774	33,474	22,148	30,221
Land provided with drainage, acres	11,247	859	7,334	658	2,993
Percentage	35.2	2.5	21.9	3.0	9.9
Land needing drainage	1,228	830	2,052	1,839	3,504
Percentage	3.8	2.4	11.6	8.3	11.6
Percentage of improved land since drainage	71.3	93.8	40.0	408.3	121.6
Percentage of decrease of timber and cut over land since drainage	61.5	34.7	20.6	23.3	7.0
Percentage of decrease of unimproved land since drainage	85.9	75.1	65.8	29.3	33.0
Percentage of decrease of swampy land or land subject to overflow since drainage	87.8	77.4	79.5	81.4	74.4
Swampy land, acres, 1920	228,337	454,360	320,893	130,111	454,360

illustrating this disposition of the country, the great changes effected through drainage during the past 50 years, and the amount of subsisting swamp areas. We see the great role agricultural drainage plays, particularly in Illinois and Iowa (ref. letter of Prof. Lehmann).

Various laws, encouraging public cooperation, gave a strong impetus to drainage. Such laws were enacted as follows (year in parenthesis is year of first laws, later repealed):

Illinois	1865	(1852)
Missouri	1859	(1851)
Iowa	1872	(1851)
Wisconsin	1862	(1852)
Minnesota	1858	

These five states were among the first 12 states to enact drainage laws. Organized drainage enterprises were started in Illinois, Iowa, Wisconsin between 1870 and 1879, in Minnesota and Missouri between 1880 and

[28] Personal communication of Prof. E. W. Lehmann.

1889. Table No. 3 shows the percentage of drainage enterprises built between 1870 and 1919 according to the Census of 1920.

TABLE 3

Percentage of Drainage Enterprises built between 1870 and 1919

	Illinois	Missouri	Iowa	Wisconsin	Minnesota
1870-1879	0.4		0.1	0.1	
1880-1889	23.1	less than 0.1	0.3	1.6	0.1
1890-1899	19.6	8.1	1.4	0.2	3.5
1900-1909	33.4	58.2	39.2	56.6	35.3
1910-1919	23.3	33.3	58.9	41.1	61.0

Organized drainage enterprises start so late that hardly any influence can be attributed to them in the decline and not very much in the disappearance of malaria. But all the data of our tables refer only to *organized drainage enterprises*. Individual and local drainage, which is meant when the older authors speak of drainage and which may perhaps have been very instrumental in the decline of malaria, is not reflected in the Census, which illustrates rather the geological structure of the country and later progress in agriculture than gives an answer to the malaria question proper.

Although considerable work in organized drainage in Illinois starts only in the 80's, interest in it, and what is most surprising, interest in its sanitary value, starts very early. In November 1819 Morris Birbeck was chosen President of the Agricultural Society; one proud object of this Society was to rid the country of unhealthy stagnant waters![29] In 1819 the Illinois legislature passed an act for financing drainage by a lottery in order to improve the health situation in the American Bottom. The first drawing of this lottery took place in 1839. The lottery did not prosper.[30] H. I. Bowditch presents Illinois in 1876 as an example to other states for the amount of drainage done there.[31]

Drainage in Missouri seems to have started only in the 90's and never played a great rôle. "There was not much drainage in the Missouri region. There the disappearance of malaria seemed to coincide *with the clearing of forests* [mainly performed after 1900, E. A.] and the introduction of screens."[32]

[29] Zeuch, p. 260.
[30] Rawlings, I, p. 34.
[31] Bowditch, 1877, p. 70.
[32] Barber, 1930, p. 8.

The 4th *Biennial Report* of the Iowa State Board of Health (1887, p. 13) recommends against malaria the drain tile which is already used throughout the state.

Malaria is a rural disease. Thus we are little occupied here with the situation in the cities. It should nevertheless be mentioned that in 1860 there was hardly any drainage in the big cities, although Boston, Brooklyn, and Chicago had some (the latter covering ⅛ of the city). While the A. M. A. Report of 1849 sounds rather optimistic, Bowditch's great report of 1876 gives a very unfavorable picture. The growth of the cities was probably too rapid for sanitary progress to be able to keep pace with it. In 1869 the Public Health Movement starts. After 1879 improvement seems considerable.[33] The mainstays of public health, even in the larger American cities as late as the 1880's, were the rampant hogs which, acting as garbage collectors and scavengers,[34] had so deeply impressed Mrs. Trollope in the Cincinnati of the 1830's.

After having given so much space to reports and opinions stating the positive effect of drainage on the disappearance of malaria, it seems but just to mention also some dissenting voices.

Dr. Stuart of Minnesota in 1874 got a rather surprising answer to number 4 of his *Questionnaire*: "Are there in your county places where intermittent fever has disappeared as a result of systematic drainage of the surface saturation?" Eleven-twelfths of the counties answered "No"; one-twelfth, "Yes."[36] Hirsch mentions that amelioration of malaria in New Jersey came about without drainage.[37] We have already quoted Barber on Missouri; of Kansas he thinks that "there is now probably about as much standing water as there was when the country was first cultivated."[38]

The most vigorous counterpart to the traditional ideas on drainage is held in the *Second Report* of the Malaria Commission of the League of Nations which we think is worth quoting extensively:

> We have already pointed out that terms like bonification and assainissement are almost universally misunderstood and misinterpreted except in the particular countries where the terms originated. We have also noted that the belief prevails in some countries that the actual measures which are necessary for making the land more suitable for cultivation and more fertile are the means by which the reduction of malaria is effected. In particular, the drainage which is necessary for agricultural land reclamation has been credited with being the chief agent concerned. It is

[33] Martin, 1942, pp. 243 ff.
[34] Ellis, 1930, p. 177.
[35] Trollope, 1832, p. 53.
[36] Stuart, 1874, p. 428.
[37] Hirsch, 1881, p. 160.
[38] Barber, 1930, p. 7.

assumed that drainage acts by reducing the breeding places of anopheles mosquitoes and therefore by reducing the numbers of those insects in the area. In support of these beliefs, it is often said, that even the ancients knew that drainage reduced malaria, and that no further enquiry into the matter is necessary. We are not desirous of saying anything in this report which will prevent useful public works being done, but, having regard to the financial aspects of the Commission's mandate, we are equally unwilling that countries should continue to believe that the kind of drainage which is necessary for agricultural reclamation of the soil is an important antimosquito measure. For it is known, quite definitely that the open ditches and canals by which swamps and marshy areas are drained for agricultural purposes are often more prolific breeding places of anophelines than were the original swamps themselves. The Italians are well aware of this. They do not regard the 'large bonifications' as an antimosquito measure, and they know that such a bonification may increase the abundance of anopheles in the area reclaimed. But they also know that, in an area where bonification has been completed, and where in consequence, the inhabitants settle permanently in better houses and in all the other circumstances of a moderately good standard of life, malaria tends more or less quickly to lose its importance as a cause of sickness and death. This good result more than compensates for an increase in the abundance of anopheles in the general environment. Thus it appears that the measures themselves are only a means to a definite end, which is to be pursued despite the knowledge that some of the measures are of a kind which favours the incidence and spread of malaria. Therefore what we learn from the Italian example is that we must not take each of the actual bonification measures (such as drainage) separately and utilize it as a single antimalarial measure in another country. When we utilize bonification we must do so as a whole; our plan must include particularly the arrangements for raising the standard of life, for better housing, education and general welfare which are an integral part of a complete bonification in Italy and (as we saw from the Palestine example recorded) in other countries where schemes of that kind have been successful. The importance of these last items in the scheme is brought home to us by the knowledge that when the inhabitants of reclaimed and highly cultivated land are not permitted themselves to reap the advantages of the increased productiveness of the soil, no improvement in malaria results.[39]

It is true that from the purely " bio-logical " point of view the results of bonification are paradoxical. Ross quite logically concluded that, as uncultivated lands are less malarious than they become by the introduction of cultivation, which always requires water and frequently requires artificial irrigation, a return to an uncultivated state through devastation " should and does " reduce malaria instead of increasing it.[40] But we have abundant proof that it only should, actually it does not. The introduction of some " socio-logical " thinking, as the Malaria Commission practiced it, seems therefore indeed indicated.

[39] Malaria Commission, 1927, pp. 28-29.

[40] Ross in Jones, 1907, p. 13.

Prosperity

The influence of improved conditions of life on the disappearance of malaria in spite of subsisting anophelines has repeatedly been emphasized by malariologists.[1] But nothing is more resistant to exact measurements and to precise analysis of causative factors, than such improvements, such prosperity.

The Upper Mississippi Valley was in large part destined to such improvements. " Southern Michigan, southern Wisconsin, northern Illinois, eastern Iowa, and eastern Minnesota were favored by soil and transportation facilities." [2] Ohio, Indiana, Illinois, Wisconsin and Iowa produced in 1839 one-fourth, in 1859, one-half, of the total wheat and corn supply of the United States.[3] Nor should the mineral resources of these states be forgotten. Lead mining in the Upper Mississippi Valley on a larger scale started after the Louisiana Purchase, first in Missouri, then in Illinois; mining in Minnesota and Wisconsin became more extensive after the 1870's.[4]

Of the following chapters, those on housing, screening, food, cattle, education, and quinine-consumption will not only illustrate factors favoring elimination of the malarial activity of the mosquito or plasmodium, but will also give indices of increasing prosperity, of better conditions of life. As a further index of such improvements we have chosen the increase of the assessed values (real estate and personal property) as given by the Census from 1860 to 1890 (Table 4). Values of 1850 are omitted because of their known unreliability.

TABLE 4

Increase in Assessed Values

	Illinois	Missouri	Iowa	Wisconsin	Minnesota
1860	$389,207,372	$266,935,851	$205,166,983	$185,945,489	$ 32,018,773
1870	482,899,575	556,129,969	302,515,418	333,209,838	84,135,332
1880	706,616,394	532,795,801	398,671,251	438,971,751	258,028,687
1890	809,682,926	887,975,928	519,246,310	577,066,252	588,820,213

Already in 1880 these five states rank second only to Massachusetts, Ohio, New York, New Jersey and Pennsylvania.

[1] Scott, I, p. 173; see also the above quoted opinions of Barber, Bass and Boyd on the renaissance of the South.

[2] Schafer, 1936, p. 68. [3] Martin, 1942, p. 25. [4] Sakolski, 1936, p. 175.

Housing

The homestead of the malaria-ridden settler was the famous log cabin, for many decades the obligatory birthplace of successful Presidential candidates. We have already given an account of its features by an eye witness (Dr. J. F. Henry) in the chapter on Iowa. In those regions where there was a dearth of timber, even more primitive contraptions such as mud huts, tents, sod houses, and dugouts gave shelter to the pioneer.[1]

Frontier doctors already suspected bad housing as instrumental in the prevalence of malaria. *Dr. Wood (1843) states that there is more malaria in log cabins than in houses.* And he thinks that the disappearance of malaria is perhaps as much due to the building of houses as to the progress of "cultivation."[2] Drake complains in 1850 of the unhealthiness of the log cabin, where all the faults of wooden buildings were carried to their extreme, particularly as the log cabin generally had but one window, sometimes none.[3] In 1851 Dr. J. F. Henry sees one of the reasons for the prevalence of malaria in the Iowa bottoms, as well as in the river towns, in the badly built houses.[4] Dr. Wilcox in 1857 accuses the log cabin as the cause of epidemic diseases in Boone County, Missouri,[5] and in 1867 Dr. A. J. Field of Iowa declares: "Preeminent among disease causes in a new prairie country are the houses" and "many new settlers live for a year or more in small, open, half-finished houses of but a single room."[6] In the same year Dr. R. C. Hamill attributes a certain decrease in fevers to the fact that "the ill improvised cabin has given place to more comfortable dwellings."[7]

Today we have sufficient scientific grounds to see in these hypotheses not wild speculation, but sound empiric observation. We know now that most of the malaria-transmitting species of *Anopheles* prefer darkness, moisture and warmth, three qualities well provided for by the log cabin, and that a dry, well lighted, well sealed house may considerably reduce the number of these dangerous guests.[8] M. Boyd considers radical improvements in housing as the essential condition for a future disappearance of malaria in the South.[9]

It is extremely difficult to date the change of house structures in the Upper Mississippi Valley (and elsewhere). Little attention was paid by

[1] Petersen, Log Cabin, 1938, p. 402.
[2] Wood, 1843, pp. 134, 136.
[3] Drake, 1850, I, p. 682.
[4] Henry, 1851, p. 303.
[5] Wilcox in Reyburn, 1855, p. 131.
[6] Field, 1867, p. 117.
[7] Hamill, 1867, p. 159.
[8] Scott, I, p. 174.
[9] Boyd in McKinley, 1935, p. 378.

most observers and historians to such humble facts as rural housing. The Census data which give only the percentage of stone houses in cities are of no help in this respect. Martin quotes Dodd's estimate that in 1860 half of the rural population of the United States was living in log houses.[10] Blagen states that by 1870 the Norwegians, who had generally arrived in the 40's, had frame houses.[11] It is all the more difficult to date changes in house building as they are as closely related to varying standards of moral and social prestige as to objective economic conditions and material comfort. In 1782 in Pennsylvania "converting the log house into more convenient habitation" was regarded as a criterion of the better, more industrious kind of settler who generally followed the "barbarious" squatter.[12]

In Lyndon, Whiteside County, Illinois, a doctor (Dr. A. Smith) built the first frame house in 1836.[13] But according to Vaughan's memoirs the habitat of settlers along the streams in Illinois was still extremely primitive in the 60's.[14] Only by the end of the 60's the log cabin seems to have faded out in Illinois in favor of a better type of house.[15] And brick farm houses were still a great rarity in the early 70's according to the memoirs of Dr. C. B. Johnson who inhabited one in Champaign County in 1871.[16] In 1879 H. R. Carter found the houses in the malarious region north of Cairo "good to fairly good."[17]

For Iowa we are somewhat better informed thanks to the research of Prof. W. J. Petersen. Dr. Henry states in 1851 in a somewhat general way: "The farmer on the prairies is prosperous. He builds good houses, good barns, plants orchards, a grove of young trees to protect the house from winds."[18] The first brick building in Adam Bluffs was erected in 1853.[19] Dr. Petersen has the impression, on the basis of all the material he has seen, that it took the settler generally from four to seven years to switch from the log cabin to the frame house. In 1856 the erection of a frame house cost $450.[20] The different cases mentioned by Dr. Petersen in his article on the "Log Cabin" show the great individual variations between settlers in so far as abandonment of the log cabin and erection of

[10] Martin, 1942, p. 106; Martin has compiled a great amount of interesting material in his chapter "Houses on the Frontier," p. 134 ff.
[11] Blagen, 1940, p. 53.
[12] St. John (Crèvecoeur), 1782, p. 57.
[13] Zeuch, p. 602.
[14] Vaughan, 1926, p. 59.
[15] Hamill, 1867, p. 159.
[16] C. B. Johnson, 1926, p. 121.
[17] Barber, 1930, p. 2.
[18] Henry, 1851, p. 302.
[19] Petersen, Log Cabin, 1938, p. 398.
[20] Personal communication of Prof. W. J. Petersen.

better houses is concerned. William Parker replaced his 1849 log cabin by a better house in 1850. But Adam Heagency stayed in his dugout in Pottawattamie County until his children were grown up; van Epp lived for 17 years in a 14 x 18 log cabin; and Calligan occupied his log cabin for seven years.[21] Farm houses in Harrison County, Iowa, had up until the late 60's the "log cabin" size of 12 x 16.[22] In Iowa the deterrents to good housing were twofold: the scarcity of timber and the difficulties in transporting building materials to the numerous settlements which were not situated along navigable watercourses. The change to better houses in Iowa was tremendously speeded up when after 1871 the railroad could transport building material, brick and frames, to places hitherto inaccessible.[23] Building material became also much cheaper as a consequence of the erection along the Mississippi between 1870 and 1905 of numerous sawmills which transformed the timber coming down on rafts from Minnesota into frames, etc.[24]

The Swedish traveler, Frederika Bremer, observed in 1850 in Wisconsin that most houses were log cabins, some were frame houses and small grey stone cottages.[25] In 1856 the Washington lawyer, C. C. Andrews, says of St. Paul, Minnesota (founded in 1849), that "it has passed from its wooden to its brick age."[26]

It may be a relatively safe estimate to say that better forms of housing replaced the log cabin in the Upper Mississippi Valley mainly in the 1860's and 1870's.

Screening

The protection afforded against malaria by mere screening, under the condition, of course, that the house is properly constructed, has been demonstrated at different times and places repeatedly since 1900.[1] The use of the screen—or rather of the principle of the screen in the form of its forerunner, the mosquito bar or net—is extremely old. It is reported from such different regions and cultures as Egypt, India,[2] South American Indians,[3] and the Romans. Primarily directed against insect pests as a nuisance, its antimalarial value was realized by some isolated observers

[21] Petersen, 1938, pp. 397, 403, 305.
[22] *Ibid.*, p. 400.
[23] *Ibid.*, p. 405.
[24] Personal communication of Prof. W. J. Petersen.
[25] F. Bremer, I, p. 634.
[26] C. C. Andrews, 1857, p. 36.

[1] Scott, I, p. 186.
[2] Futcher, 1936.
[3] Métraux, 1942, pp. 22, 138.

who even succeeded in making this observation fit into their miasm theories. Insight followed experience, but antedated true scientific explanation, as in the case also of measures like drainage, stream regulation, better housing, cattle breeding, etc., all originally adopted for quite different purposes.

One of the first to have advocated in this country the use of the gauze veil or " canopeum " as an antimalarial measure seems to be the anonymous book reviewer of the *American Quarterly Review* of 1828 (p. 298) whom we already know as protagonist of the animalcular theory, etc. In this case he only repeated the prescriptions of McCulloch whose book he reviewed. In 1841 Dr. Lunsford P. Yandell in an *Essay on Bilious Fever* recommends—besides planting and draining, cultivating the soil, selecting proper sites for dwelling, i. e. at a certain distance and south of water courses " which might prevent half the fever which now afflicts the country "—the spreading of a piece of " gauze " over window openings at night, as the Romans had done so successfully.[4] In 1880 Dr. W. C. Maull of Middletown, Illinois, published an article on " Window Screens as a Prophylactic of Malarial Poisoning," based on personal observations and in which he reasoned that the screens probably arrested the cause of the disease: " minute cryptogamic plants of the family of *Palmellae*." [5] When Dr. A. F. A. King, one of the protagonists of the hypothesis—proved 15 years later by Ross,—that malaria was transmitted by mosquitoes, asked in 1882 that a gigantic screen be drawn around Washington, he was, of course, the object of many jokes by people who nevertheless profited greatly from the pieces of this screen placed before their own windows.[6]

Mosquito curtains appear to have been used very early, especially on the river, where already the first explorers (DeSoto, Marquette) complain of the mosquito pest (" mosquito cloth " was known and used in Virginia as early as 1684).[7] The Jesuit Father, DuPoisson, who traveled upon the Mississippi in 1727 speaks of " baires," under which the travelers tried to find protection against the mosquitoes during the night.[8] Boyd reproduces the instructions of F. Cumming (1810) for travelers to use mosquito curtains on the Ohio and Mississippi Rivers; otherwise they could not reckon on one night's undisturbed repose during spring, summer or autumn.[9] The Cass Expedition of 1821 used gauze nets.[10] Timothy Flint (1826), complaining of the innumerable mosquitoes in Missouri, says

[4] Yandell, 1841, p. 168.
[5] Burr, 1930, p. 683.
[6] Garrison, 1929, p. 887.
[7] Blanton, 1930, p. 53.
[8] Drake, I, p. 116.
[9] Boyd, 1941, p. 230.
[10] Schoolcraft, 1825, p. 61.

that "nets are of little help," [11] which after all is an indirect proof that they were used. Captain Hall notes mosquito curtains in a neat log cabin on the shore of the Mississippi which he visited in 1829.[12] When the famous English geologist, Sir Charles Lyell, traveled on a Mississippi steamer in 1846, his berth was provided with a good "mosquito net." [13] Nets were used in Palmyra, Missouri, in the 70's.[14] But in so far as effectiveness is concerned the bed curtain is, of course, for several reasons much inferior to the screen which covers windows and doors, and the curtain can only in a very limited sense be regarded as the forerunner of the screen. The intense heat developing under the curtain limits its use considerably and it does not protect against the bite of the mosquito during the evening hours passed outside of bed. Much more of a direct ancestor of our wire screen is the "gauze" of Dr. Yandell, covering windows and doors. That such contraptions were actually in use could fortunately be ascertained e. g. from the personal memoirs of Prof. J. T. McClintock, Iowa City, who remembers having helped in their installation while a boy in the 1870's [15]

"When the application of metallic wire cloth to doors and windows was first introduced is uncertain although some was manufactured as early as 1865." [16] Unfortunately the data collected below do not give any certainty as to the date of general screening. According to Hackett screening was introduced in the late 70's and early 80's.[17] H. R. Carter saw but few screens north of Cairo in 1879.[18] Dr. Carl E. Black, Jacksonville, Illinois, has been kind enough to provide me with the following information:

Much to my surprise, two Encyclopedias I have consulted, say nothing of fly-screens as a sanitary measure. A friend of mine who was with the largest hardware firm in the west (Simmons, St. Louis) says as nearly as he can remember, that firm began selling "Fly Screening" about 1885. My own idea would have been about 1890. I am thinking of the time when our house-wives abandoned their "fly brushes" for the dinner table and had their houses screened.

About 1880, extensive studies were made of flies as carriers of disease. Fly screens must have followed rather quickly. First mosquito netting was used and soon replaced by screen wire. During World War I, I was overseas, in charge of Military Relief and Hospital Service for the Red Cross. In Greece I offered to screen two or three of the best Hospitals—they were all using mosquito netting over the beds—but there was so much prejudice against screens that I gave it up.

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[11] Flint, 1826, p. 262.
[12] Hall, 1829, III, p. 356.
[13] Lyell, 1850, II, p. 191.
[14] Pryor, 1943, p. 68.
[15] Personal communication, Dr. McClintock.
[16] Boyd, Symposium, p. 7.
[17] Hackett, 1937, p. 290.
[18] Barber, 1930, p. 2.

Barber states of Missouri: "Bed nets were in common use in the early days; wire screen began to come in during the early eighties." [19] Bass writes in 1927: "Thirty years ago wire screens for houses were practically unknown . . . Bed nets or mosquito bars were formerly depended upon and these were probably less effective than screens." [20] Boyd states in his *Malariology* that extensive use of screening in the South was first made in 1900-1905.[21] Since then screening has taken gigantic proportions. According to Prof. Riley there is, for example, in Minnesota an annual expenditure of over one and a quarter million dollars for wire screen, the vast proportion of which was used for protection of the residents against pest mosquitoes.[22] The latter figure also shows very graphically how much the decrease of malaria is indeed an economic problem; screening can only be afforded by a population in good economic conditions and is only effective when combined with good houses.

These are the rather contradictory data generally given by malariologists. Mr. R. W. Bacon, secretary of the Insect Wire Screen Cloth Bureau, New York, has been kind enough to provide me with the following highly interesting data:

A clean cut date on which wire window screening was first used seems next to impossible of determination . . . The Clinton Wire Cloth Company, Clinton, Mass., which is now owned by the Wirewick Spencer Steel Company, first made insect wire screen cloth in *1857* . . . It has been pretty conclusively established that the production of woven wire window screening was an outgrowth of the manufacture of horsehair sieves which in the early 1800's were commonly used in all well equipped households for sifting the bran out of home ground meal. In 1834 Gilbert Bennett & Co., which is now Gilbert & Bennett Mfg. Co. of Georgetown, Connecticut, experimented with fine drawn iron wire woven on a carpet loom in an endeavor to produce a sieve that would be more durable than their former horsehair sieves.

The experiment seems to have been eminently successful, but the outbreak of the Civil War in 1861 shut off the important markets for sieves and left the Gilbert Bennett Co. with an alarmingly large amount of woven iron wire cloth on their hands. Whereupon, exercising their proverbial Yankee ingenuity, the Gilbert Bennett Co. gave their excess stock of wire cloth a protective coat of paint and introduced it into northern markets for window screening.

Among the *Private Notes* of Trautwine, the engineer, who built the Panama Railroad (finished in 1855) the following curious remarks are found, which would push the use of screens even beyond Mr. Bacon's data:

A veil over the face is a partial protection from miasmatic vapors. Dry rooms are

[19] *Ibid.*, p. 8.
[20] Bass, 1927, p. 9.
[21] Boyd, 1930, p. 12.
[22] Personal communication, Professor Riley.

important. Sheet iron stoves. When camping out a large brushwood fire at night. Keep closed such doors and windows as open to winds blowing across marshes; very important, especially to the sick. *But if they must be open have screens of gauze or copper wire* [italics mine, E. A.], which is better than iron, if near salt water, as it does not rust. Mosquito nets are good, not only against insects, but miasma. Bolting cloth is strongest and best.[22a]

Screening ranks high among antimalarial measures. L. L. Williams, Jr., says: "Drainage caused the major part of this recession (in the northern United States); residual malaria left the area because of the screening of homes." [23] According to Barber "disappearance of malaria in the Missouri region where there was not much drainage, seemed to coincide *with the clearing of the forests* [there was extensive deforestation in Missouri between 1900 and 1920, E. A.] *and the introduction of screens.*" [24] Barber on the other hand emphasizes that screening is no indispensable factor. He gives as an example that in certain rural localities of New Mexico malaria had increased rapidly in the late 20's, although the percentage of screened houses was high—over 90 per cent. In both amount and quality the screening was as good as it was in most of the rural regions in the Northern states at that time, and must have been far superior to that which obtained in these states at the time when malaria was rapidly decreasing. Furthermore, Barber states: "Screening is little practiced in Europe, but some regions there have shown a rapid decrease in malaria." [25]

Food

The frontierman's food has been described in what seems a somewhat idealized manner by Drake (I, p. 653), and a good summary of many sources has been given recently by E. W. Martin.[1] It is a fact that since Wood,[2] medical observers have repeatedly attributed bad health and malariousness of the frontiersman not only to bad housing but also to bad eating habits and bad composition and cooking of food, rich as it was in itself. We refer to F. Gerhard,[3] Illinois; Dr. Henry,[4] Iowa; Dr. Nichols;[5] and Dr. R. C. Hamill.[6] It is impossible to analyze here what changes in food might have been instrumental in the decrease of malaria as research on the actual relation between food and malaria is sadly neglected up to

[22a] J. B. and F. Bishop, *Goethals*, New York, 1930, p. 103.
[23] Williams, 1941, p. 365.
[24] Barber, 1930, p. 8.
[25] *Ibid.*, p. 10.
[1] Martin, 1942, pp. 66 ff.
[2] Wood, 1843, p. 136.
[3] Rawlings, I, p. 41.
[4] Henry, 1851, p. 303.
[5] Nichols, 1861, p. 229.
[6] Hamill, 1867, p. 159.

this day. But for this very reason I have considered it my duty to signalize these early observations of men who so often noted correctly, even when they were unaware of the real factors producing the results observed by them. This may help to change a certain attitude towards the problem of food and malaria, where scientific curiosity is apparently satisfied by the statement that " well fed " people, whatever that may be, receive from this fact no protection against malaria.

Education

In 1848 twenty-seven year old Rudolf Virchow, who later became the creator of modern pathology, was sent by the Prussian Government to study an epidemic of typhus in Upper Silesia. The report he brought back was rather surprising. It did not end with the recommendation of drugs but of democracy and as one of its main elements, of education, to overcome the Silesian typhus. Education at that time could not yet give real knowledge of disease as it can today. But it could change the attitude towards disease and break the indolence so fatal to all endemic areas. Virchow had with one stroke replaced the climatic theory of epidemics by a social theory which, despite the later threat of the new science of bacteriology, continued to make its way.[1] The emphasis laid on education by the Malaria Commission of the League of Nations clearly reflects the attitude of a very great number of contemporary malariologists.

> The stabilisation of population, following on its settlement on the land, may not only improve its economic conditions but may also influence favorably its educational standard and consequently its sanitary conditions—by making school attendance more general and more regular.[2]

The 50's and 60's were years of great efforts to improve schools and to obtain free schooling.[3] The following data taken from the Census give an idea of the results obtained and the educational standards of the Middle West as compared to older states.

TABLE 5

Number of Schools and High Schools

	U. S. A.	Illinois	Missouri	Iowa	Wisconsin	Minnesota
1870	107,880	8,489	4,120	3,836	3,795	870
1880	225,917	15,203	10,329	12,635	6,588	4,784

[1] See E. H. Ackerknecht, *Arch. f. Gesch. d. Med.*, XXV (1932), pp. 99 ff., pp. 147 ff.
[2] Malaria Commission, 1927, p. 28. [3] Martin, 1942, pp. 295 ff.

Illiteracy in Per Cent of Population

	U. S. A.	Ill.	Mo.	Iowa	Wis.	Minn.	Mass.	N. Y.	Ala.
1880	17.0	6.4	13.4	3.9	5.8	6.2	6.5	5.5	50.0
1890	13.3	5.2	9.1	3.6	6.7	6.0	6.5	5.5	41.0
1900	10.7	4.2	6.4	2.3	4.7	4.1	5.9	5.5	34.0

Cattle Breeding

The discovery of the fact that many *Anopheles* species, when faced by the opportunity to feed either on man or on domestic animals, especially cattle, prefer the latter (Zoophily of E. Roubaud) has solved many riddles of malariology.[1] To Hackett this is the fundamental explanation of "natural regression" of malaria observed in so many European countries with improving standards of living or at the end of the pioneer period in new countries. While with *Anopheles* which feed on man under all conditions, only the elimination of breeding places can bring about a decrease of malaria, with zoophilic species the increase in cattle near human habitations—one of the organic elements of agricultural progress—can create a barrier which protects man against malaria and leads to its decrease in spite of the *Anopheles* still existing in great numbers.[2] The different behavior of Anopheles necessitates the application of special measures in every given locality, the "species sanitation" of Malcolm Watson, as measures appropriate to one ecological type, one species or race, may be superfluous, costly, and even ineffective in the case of another type.

Knowledge of Anopheles biology is unfortunately still very scanty, but we are free to include the study of cattle increase into our examination of the reasons for the disappearance of malaria from the Upper Mississippi Valley, as the main vector *A. quadrimaculatus* as well as *A. maculipennis*, *A. punctipennis*, *A. crucians* have been seen at least locally to be zoophilic.[3]

Empirical observations of the protective value of cattle against malaria seem relatively rare for past periods. If available they are of course so closely interwoven with wrong speculations that they may—as in the following quotation from Rush—have appeared completely valueless to the proud laboratory man of the 19th century, who unfortunately had not even that inkling of zoophily that Rush had. Increasing knowledge has shown that their observational basis was sound, and that it may sometimes even

[1] Scott, I, p. 200.
[2] Hackett, 1937, pp. 86 ff.
[3] Moulton, *Symposium*, 1941, p. 80, p. 307.

pay to look for the sense in observations of great men in the past instead of indulging in the cheap pleasure of feeling superior to them.[4]

Offal matters, especially those which are of a vegetable nature, should be removed from the neighbourhood of a dwelling house. The dung of domestic animals, during its progress towards manure, may be excepted from this direction. Nature which made man and these animals equally necessary to each other's subsistence, has kindly prevented any inconvenience from their living together. On the contrary, to repay the husbandman for affording a shelter to these useful and helpless animals, nature has done more. She has endowed their dung with a power of destroying the effects of marsh exhalations, and of preventing fevers. The miserable cottagers in Europe who live under the same roof, and in some instances in the same room with their cattle, are always healthy. In Philadelphia, fevers are less known in the neighbourhood of livery stables, than in any other part of the city. I could mention a family that has lived near thirty years near a livery stable in a sickly part of the city, that has never known a fever but from measles and small pox.[5]

Not only has the discovery of zoophily rehabilitated Rush in general, but even the ridiculous " cow dung " seems to be not without importance once experiments have shown it to be the substance attracting mosquitoes to cows.[5a]

In his repeatedly quoted report of 1874, Dr. Angear of Iowa mentions, besides damming and ditching, the increase of cattle as a third factor in the decrease of malaria.[6] Dr. Burr, Michigan, quotes very interesting observations of pioneers on the preference of mosquitoes for cattle.[7]

Increase in cattle is, of course, only relevant to our problem if it is an increase in cattle housed in stables, not on the ranch, that is, in dairy cattle. But there is no possible doubt that at least for Iowa, Wisconsin, and Minnesota, cattle increase was an increase in this sense. Wisconsin is today still " the dairy State." Wisconsin and Minnesota are big cheese producers. *Industrial* dairying seems to have started in the 50's, and about the same time dairying in general started shifting over from New England to this region in the United States. It is now the largest industry and agricultural enterprise in the country. The cornbelt, following a general law of agricultural surplus production, turned to cattle breeding for the consumption of its surplus grain.[8]

[4] See for this point also Henry E. Sigerist: Ambroise Paré's Onion Treatment of Burns, *Bull. Hist. Med.*, XV, 1944, p. 143.

[5] Rush, 1797, p. 276.

[5a] Scott, I, p. 203.

[6] Angear, 1874, p. 395.

[7] Burr, 1930, p. 691.

[8] Sakolski, 1936.

Professor S. A. Witzel, Madison, Wisconsin, has kindly supplied me with the following information concerning Wisconsin:

Prior to 1860 Wisconsin was for a time the leading wheat producing state in the Union. With the coming of rust and competition from the prairie states to the south and west, Wisconsin farmers were forced to change over to livestock type of agriculture. Because of the large acreage of grasslands due to marshes and more particularly hillsides and partially wooded pastures dairying flourished.

Merk states that dairying started in Wisconsin during the last years of the Civil War because of the high cheese prices, and the exhaustion of the wheat soil. In 1864 the first cheese factory was built. At the end of the 60's there existed more than 1,000 such factories. The first creamery in Illinois opened in 1870.[9]

These more prosaic explanations: competition from newer wheat and corn producing states, necessity of feeding the surplus corn to cattle, high prices for dairy products, give probably the fundamental reasons for this change. Historians explain it generally by the more dramatic insect pests in Iowa and Wisconsin: grasshoppers in 1867, 1873-1876; chinchbugs in 1881 which ruined the wheat farmers. While these pests may have speeded up the process and made it more conscious, they are too late to explain a change which, judging from all other records, had begun in the late 50's, and was particularly pronounced in the 70's. Iowa, Missouri, and Texas were the leading cattle states in 1860.[10]

Table 6 shows the increase in cattle in the five states from 1850-1890 according to the Census. In 1900 a regressive movement starts, which however as it lay in the post-malarial period is irrelevant to our subject.

Table 6 shows a rather significant relation between decrease periods of malaria and sudden increase in cattle in Iowa, Wisconsin and Minnesota, the actual dairy states. The cattle-man ratio (Table 7) shows a significant increase in the same states, especially in the period of sudden decrease of malaria. It reveals, particularly for Iowa, the change in economic structure brought about by dairying. In this respect even the Missouri data are significant. The figures corroborate the opinion of Barber and Carter that in Illinois, a hay-and-corn country, increase in livestock was not important for the decrease of malaria. It is there attributed to ditching.[11]

[9] Merk in Schmidt-Ross, p. 415.
[10] Martin, 1942, p. 15.
[11] Barber, 1930, p. 2.

TABLE 6

Increase in Cattle, 1850-1890

	Illinois	Missouri	Iowa	Wisconsin	Minnesota
1850	912,036	791,510	136,621	183,433	2,002
1860	1,583,813	1,168,984	540,088	521,800	119,257
1870	1,715,586	1,153,695	1,006,235	693,294	310,379
1880	2,389,422	2,080,932	2,612,036	1,128,800	659,050
1890	3,063,119	2,969,716	4,895,550	1,647,947	1,373,579
1900	2,381,010	2,345,978	4,077,367	1,691,314	1,305,871

TABLE 7

Cattle-Man Ratio 1850-1890

	Illinois	Missouri	Iowa	Wisconsin	Minnesota
1850	1.0	1.1	0.7	0.6	0.3
1860	0.9	0.9	0.8	0.6	0.7
1870	0.6	0.6	0.9	0.6	0.7
1880	0.7	0.9	1.6	0.8	0.8
1890	0.8	1.1	2.5	0.9	1.0

Mosquitoes

Cattle breeding and drainage are, among the points examined so far, the only ones to have a direct bearing on the ecology of the Anopheles. Hackett, Russell, Scharff and Senior-White,[1] considered deviation of vector species from man to cattle the only naturalistic measure showing promise of success or worthy of the expenditure of public funds.

Mosquitoes have been reported to be the curse of the Mississippi ever since white men traveled on it. The first to complain were De Soto and his expedition in 1540.[2] Good Father Marquette equally complains of the mosquito plague near the mouth of the Missouri,[3] where he observed interesting contraptions of the Indians to protect themselves against the mosquitoes. Particularly eloquent is the Jesuit Father DuPoisson who travelled in September 1727 with two other priests on the Mississippi

[1] Hackett, L. W., Russell, P. F., Scharff, J. W., Senior-White, R. The Present Use of Naturalistic Measures in the Control of Malaria. *Bull. Hlth., Org. L. of N.*, 1938, 7: 1016.

[2] Elvas, 1907, p. 263.

[3] Marquette, 1917, p. 251.

(they did not get the ague!).[4] He introduces an excellent description of the different sorts of gnats as follows:

> But the greatest torment, in comparison with which all the rest would be but sport, which passes all belief, and has never been imagined in France, still less actually experienced is that of the musketoes—the cruel persecution of the musketoes. The plague of Egypt I think was no more cruel . . . This little insect has caused more swearing since the French have been in Mississippi, than had previously taken place in all the rest of the world.

We have already mentioned Alexander Henry's statement on the abundance of mosquito "clouds" in Illinois (1760-64).[5] Boyd quotes extensively a very picturesque passage from T. L. McKenney's Memoirs concerning the mosquito plague in Illinois in 1827.[6] Schoolcraft, whose report of the 1821 expedition of Governor Cass we have repeatedly used in the chapter on Illinois, has also his say concerning the mosquito pest.[7] Major Long's Expedition (1819-1820) suffered frightfully from mosquitoes in Illinois as well as in Missouri.[8] Timothy Flint says of the mosquitoes in the Upper Mississippi Valley: "In some parts and some seasons, musquitoes are excessively troublesome while in others there are not more than there are at the North."[9] Mosquitoes in Minnesota were already the terror of 18th century explorers.[10]

The *Malaria Survey* of 1941 in the Upper Mississippi Valley has shown that *Anopheles quadrimaculatus* (the main vector) is found everywhere, sometimes in great densities; *A. occidentalis* and *A. Walkeri*, which are doubtful transmitters, also exist in great densities. *The Upper Mississippi Valley is thus another beautiful example of "anophelism without malaria."* The question arises now, are these Anopheles actually the same as the "musquitoes" mentioned in the heyday of malaria and only ineffective because of the lack of carriers or because their victims moved away? Are they the same, but reduced below the level of density necessary for the endemicity of malaria? Are they the same, but barred by cattle, or better housing, or greater resistance of the population? Or have they changed in their habits or have harmful races or species been replaced by more harmless ones? Of course, they seem to be the same species as those described by Howard, Dyar and Knab in 1912-1917. But even if this could be established, it would not mean much, as these observations come

[4] Drake, I, p. 116.
[5] Rawlings, I, p. 19.
[6] Boyd, 1941, p. 230.
[7] Schoolcraft, 1825, p. 61.
[8] James, 1823, I, p. 41; II, p. 107.
[9] T. Flint, 1826, p. 238.
[10] E. Parsons, 1918.

from the post-malarial period. And even if the identity of species could be ascertained by entomologists from Father Du Poisson's detailed descriptions of 1727 it would not help us since we have learned from Hackett and Missirioli that one species may have several races, discernible only by methods recently developed, and that one of these races may be a transmitter, the other not. On the basis of the historical evidence there is no possibility of answering the tantalizing question of the identity of the Anopheles of today and of 70 years ago. While most of the other questions could be answered at least partially, the mosquito question opens a gap which we cannot bridge with our material. This may be without basic importance should we—as seems likely—actually be dealing with a region where the entomological problem is not the fundamental one. But this situation may also deprive us of the central element of the answer to our problems should the fundamental character of the region be different.

Although they do not pertain to the Upper Mississippi Valley and are not of local importance, we should like to give here two observations of Drake on mosquitoes, not only because our present knowledge of Anopheles ecology seems to explain them, but also because they again prove the high standards of observation among at least the great men of our profession in the pre-microscopic and pre-chemistry era. Drake reports (I, 164) that "the salt deposits at the Upper Arkansas River diminish the prevalence of intermittent and remittent fevers." Today we know that many transmitting species do not breed in salty water and that saltbreeding Anopheles may be harmless. Furthermore Drake (I, 79), following here the queer Dr. Cartwright of Natchez and disagreeing with the popular slogan of wholesome "sea breezes," explains the lack of autumnal fever in La Fourche, Teche, Attakapas in Louisiana, is due to the very dense covering of all waters by *Jussieua grandiflora*. That this explanation was right seems absolutely possible after R. B. Williamson's successful use of "herbage cover" for the control of mosquito breeding.[11]

Quinine

In our list of factors influencing the decrease of malaria it is difficult to find a "logical" place for quinine, the most widely used among the alkaloids of the Cinchona tree, as its position is unique. It does not act in changing the ecology of the mosquito carrier like the transfer of settlements from watercourses inland, cultivation, better housing, screening, breeding

[11] Scott, I, p. 189.

of dairy cattle, or changes in weather; it does not act in an ill defined way on the human carrier, like all elements of economic and cultural progress; it attacks directly the disease-causing parasite, and quinine treatment of malaria-infected patients is therefore regarded as the most direct anti-malarial measure by the Malaria Commission of the League of Nations. This method of action is perhaps decisive for the future solution of the malaria problem, as it seems to be the most economical one. What quinine itself actually accomplishes in this way has been in dispute ever since Cinchona bark was brought to Europe around 1630. Cinchona has not only been one of the most useful and spectacularly effective, but also one of the most controversial drugs throughout history. It has not escaped this fate in so far as its rôle in malaria decrease in the Upper Mississippi Valley is concerned.

Palmer, professor of medicine in Detroit exclaims in 1858:

> Without Quinine or some similar article the material and social development of this whole region must have been retarded for at least half a century, if indeed it had not been prevented altogether. What would Ohio or Indiana or Illinois or Wisconsin or the young Iowa or Michigan have been at this day had not their early settlers been protected from the pestilence by this agent of power.[1]

Of the four historians of malaria in the United States, Boyd regards quinine as a very important factor in the decrease of malaria in the United States where the consumption has become more widespread and general than perhaps in many other endemic regions of the world.[2] Barber thinks that of all factors brought up for explanation of the decrease of malaria possibly only quinine was indispensable. (On the other hand he shows that quinine alone cannot prevent a serious prevalence of malaria.[3]) C. C. Bass states: "The decline of the prevalence of malaria in all countries from which it has declined during modern times coincides almost exactly with the use of quinine in those countries." He explains the slower decrease in the South by the lesser use of the relatively expensive quinine by the poor and ignorant rural Negro.[4] But in all fairness it must be stated that Bass' hope of the passing of malaria even in the South between 1937-1947, based mainly on these speculations, unfortunately has not come true.

W. T. Howard, Jr., regards quinine as the most important factor in the decline of malaria in Baltimore, where it had almost entirely disappeared

[1] Palmer, 1858, p. 43.
[2] Boyd, 1930, p. 13.
[3] Barber, 1930, p. 11, p. 10.
[4] Bass, 1927, pp. 10-11; 1926, p. 13.

before the institution of an organized antimosquito campaign in 1910.[5] Sir William Osler in speaking of malaria in the district about the western end of Lake Ontario and the northern shores of Lake Erie, states: "The marshes are still there and the Anopheles are there, but the disease has gone. As in parts of Italy, the important factor appears to have been the cinchonizing of the inhabitants."[6] Swellengrebel regards as the main factor for the decline of malaria in Holland better medical care and quinine as the Anopheles still persists.[7] Kortenhaus ranks quinine next to drainage in the demalariazation of the neighboring Rhineland.[8] Robert Koch, from observations made in Java and Sumatra, concluded that quininization of the people was a very judicious measure and that the diminution of cases in the Dutch Indies was due to it. Koch's method was tried in Italy and in the French and German possessions but the results were not as good as the antimosquito measures used, for example, in Klang and Ismaila.[9] This does not prove very much in itself, as the success of all antimalarial measures varies very widely locally, depending upon such regional factors as metereological conditions, ecology of the transmitting mosquito, social and cultural conditions of the population affected, etc. For example, the mechanical application of American antimosquito measures so eminently successful in Cuba and Panama was a failure in Europe and also in the Philippines, because of different breeding habits of the local vectors.

The Malaria Commission of the League of Nations merely summarizes the opinion of a great number of malariologists in saying:

> The Commission considers the treatment of malaria infected persons to be one of the most important measures even from the point of view of prevention. It considers that, in rural areas and localities under primitive conditions, the State must make arrangements for the treatment of patients according to the means available, and that at least an arrangement for the gratuitous supply and distribution of quinine in such areas is indispensable . . .[10]

We must frankly recognize that there is another line of thought, represented by men of no less experience, merit and acumen. Hackett states that we were expecting far too much of quinine. Quinine does not kill the sporozoites and thus cannot prevent infection; it cannot sterilize the sexual forms of *Plasmodium falciparum*, so that cases under treatment continue to infect mosquitoes, no intensification of treatment resulting in the radical cure of more than a certain percentage of infected persons.

[5] Howard, 1924.
[6] Osler, 1917, p. 621.
[7] Swellengrebel, 1926, p. 178.
[8] Kortenhaus, 1928.
[9] Scott, I, p. 237.
[10] Malaria Comm., 1927, p. 22.

What it can do is to interrupt the acute attack.[11] Hackett emphasizes that treatment may rather lengthen the duration of infection, and that the use of quinine in Spain during hundreds of years has been, as far as endemicity is concerned, without success.[12]

As far as our special historical problem is concerned Prof. T. J. LeBlanc, Chief of the Department of Preventive Medicine, University of Cincinnati, writes:

> As to the reasons for the decrease in malaria, my own opinion is that quinine had little or nothing to do with its decline. The major influence was the decrease in standing water, no matter what brought about this decrease . . . Quinine perhaps relieved suffering and cured sick people or at least made them feel less ill. That it eliminated much malaria is open to doubt. In the first place, the vast majority of the so-called chill tonics used by the people in this area against malaria contained too little quinine so that when they were used in the dosages recommended, they were not therapeutically active.
>
> Finally under supervised conditions and with unlimited quinine available and where the dosage is given under supervision the attempt to control malaria by quinine therapy has been somewhat of a disappointment. (Clark, Gorgas Memorial Hospital, Panama.) Of course, it does not necessarily follow that work done in Panama would be paralleled by experience in the 19th century in the Mississippi Basin, but unless there is evidence to the contrary I would suspect that the parallel is pretty apt.[13]

Dr. C. A. Harper, who for decades has been the Secretary of the Wisconsin State Board of Health, writes:

> I do not believe that the administration of quinine back in the early days had any material effect in abating or curing so-called, a case of malaria as it was not used properly and not in sufficient quantities. In the present century there is better knowledge in the use of quinine in combating malaria.[14]

Before defining our position it seems advisable to examine the evidence on the use of quinine in the United States and the Upper Mississippi Valley during the last century (in so far as such evidence exists) in order to find out when, how, and with what success quinine was actually used.

The Evolution of Quinine Treatment in the United States and the Upper Mississippi Valley during the 19th Century

The bark of the Cinchona tree, generally called " the bark " was replaced in the treatment of malaria by the sulfate of one of its alkaloids, quinine, discovered in 1820 by the French chemists Pelletier and Caventou.

[11] Hackett, 1937, p. 178.
[12] *Ibid.*, pp. 284-285.
[13] Personal communication of Prof. LeBlanc.
[14] Personal communication of Dr. Harper.

Quinine inherited the glory and prejudices and the aura of controversy surrounding its predecessor. The bark, brought around 1630 to Europe by the Jesuits (the elaborate story of the Countess of Chinchon is a fable), had immediately become the subject of heated controversies. It had found such illustrious defenders as Sydenham, Torti, Lancisi and later, Lind and Clark. R. Morton and T. Willis had, after periods of doubt, joined their camp. Talbor, a physician gifted with the ingenious business manners of a quack, had propagated its use all through Europe and, as seems to have happened so often in the history of malaria and quinine (and not only there), reaped the fame deserved by better men. But the bark had also found such mighty enemies as Gideon Harvey, Ramazzini, and later J. Johnson and W. Burnett. At the basis of these heated discussions was much ignorance and prejudice, and also the different therapeutic value of the often corrupted barks used by the different authors. In the beginning there was a real confusion between the original Quina Quina (the bark of *Myroxylon*, the Peru Balm tree) and *Cinchona* substituting it and assuming its name. This has been brought out in an admirable paper of A. W. Haggis: "Fundamental Errors in the Early History of Cinchona" (*Bull. Hist. Med.* X, 1941, pp. 417-459, 568-592), by far the best and clearest contribution to the history of Cinchona in three centuries of legends and confusion.

One of the earliest accounts of the use of the bark in North America is that of the buccaneer surgeon Lionel Wafer who seems to have used it in Virginia in 1682-1683 and 1688-1690.[15] Blanton gives numerous data on the prescription of bark in Virginia throughout the 18th century. It was much used, but had also its enemies. It was falsified here also. Sometimes it was even given to Negro slaves. Arthur Lee, the physician among the six famous sons of Thomas Lee, later a diplomat, won a gold medal at Edinburgh in 1764 with a thesis "De cortice Peruviana."[16] Boyd quotes the observations of Peter Kalm, the famous Swedish botanist, on the popularity of the bark in the Atlantic colonies, 1748-1750.[17] Benjamin Franklin, of course, recommended the use of the bark.[18] Robert Jackson, a British army surgeon during the War of Independence, experimented a great deal with the then current methods of treatment in intermitting fevers (emetics, cathartics, bloodletting) and relied on the Peruvian bark as the chief remedy. He speaks of the opposition to the bark

[15] Wafer (1699), 1903, p. 106.
[16] Blanton, 1931, pp. 50, 66, 67, 168, 185, 226.
[17] Boyd, Symposium, p. 4.
[18] Bass, 1926, p. 13.

still encountered in Germany and France, and even in England. He compares the greater mortality in those regiments where bark was not used (mostly Hessians) with the mortality of those regiments where it was used.[19]

That the other side in this war used the bark too, is shown by the purchase of 300 pounds of bark by the Continental Congress in 1776. O. W. Holmes repeatedly refers to the prescribing of bark in New England in the last decade of the 18th century, combined, of course, with purging; and to the suspicions against the bark.[20] In 1802 William Nelson of Virginia graduated at Philadelphia with a thesis "Observations on the Management of the Peruvian Bark." He makes some nice observations on the action of the bark on the pulse, but the rest is pervaded by the Rushian blood-letting philosophy. It is significant that two classics on malaria: Sénac and Cleghorn, who had their American editions in 1805 and 1809, are both strongly pro-bark.[21] We have already mentioned Dr. A. F. Saugrain treating malaria with the bark in St. Louis, 1808-1809.[22] Currie recommends the bark in the intermission (the usual procedure of this time) but otherwise he mainly relies on bleeding, purging, emetics, etc.[23] Bark is also recommended in A. P. Wilson's *Treatise on Febrile Diseases* (American edition, 1816). Dr. McPheters (Missouri) used the bark, 1819-1821. On the other hand the standard treatment of malaria in 1820 in the U. S. Army, as described by Ashburn,[24] contains no mention of the bark. Dr. Edwin James, the physician, botanist and memorialist of Major Long's Expedition, 1819-1820, seems to have been only a half hearted supporter of quinine; he writes that Peruvian bark is much used in the Mississippi Valley, "but often so injudiciously as to occasion great mischief."[25] How hard customs die, is shown by the fact that Vaughan's father used the *bark* as a prophylactic against malaria as late as 1865.[26]

This was the medical environment into which quinine was borne in 1820. It was manufactured immediately by its discoverers, and immediately the fight was on concerning its usefulness in general, the time of application and the dosage. Early dosage was so small as to be practically ineffective. In order to be efficacious quinine had not only to win recog-

[19] Jackson, 1795, pp. 207, 215.
[20] Holmes, 1838, pp. 64, 66, 73.
[21] Sénac, 1805, p. 224; Cleghorn, 1809, p. 138.
[22] It is interesting to notice that Saugrain, while treating the malaria of Breckenridge in Gallipolis in 1794, did not yet use quinia. See Selter, p. 25.
[23] Currie, 1811, p. 21.
[24] Ashburn, 1929, p. 44.
[25] James, III, p. 182.
[26] Vaughan, 1926, p. 61.

nition in principle, but also to overcome the prejudices which confined the use of it to small doses or restricted only to the intermission period or after several paroxysms, and which made it second to the traditional blood-letting, cathartics and emetics. One of the first protagonists of quinine in France was the famous physiologist Magendie (1782-1855) who could refer to the recommendation of quinine by such authorities as Double, Villermé (1781-1863), Chomel (1788-1858), Elliotson (1791-1868), Dickson.[27] Webb refers to Chomel as giving 62 gr. per day as early as 1828.[28] Groussin, a pupil of Bally (1775-1866) and Bretonneau (1771-1862), tells us of the prejudices against quinine in the 20's, how they were partly overcome by his teachers, how both approved the traditional blood-letting, surgery and emetics, how both used high doses (Bally gave from 2 to 6 gr. to 2 ounces per day) without injurious consequences.[29] Louis (1787-1872), Andral (1797-1876), Trousseau (1801-1867) and Maillot (1804-1894) defended similar points of view. That quinine and efficient doses of quinine had nevertheless a hard time of it even in France under such favorable conditions is shown by the article of A. Ménard (*Rev. Méd. Franç. Étr.*, XII, 1823, 280) against high doses of quinine, or by the symptomatic statement in a Paris thesis of 1831 (A. Ferey-Derney: *Propos sur les inflammations spéciales*, Paris, 1831, p. 17):

> Les fièvres intermittentes simples ne réclament pas toujours l'emploi des préparations de quinquina lorsqu'elles coincident avec une tuméfaction de la rate; une ou deux sangsues à l'anus préviennent le retour des accès aussi surement que les médicaments dits " antipériodiques."

For the English speaking world it was very important that the great contemporary authority on tropical diseases, James Johnson, was a pure " mercurialist " and opposed to bark and quinine.[30] Quinine was accused by its adversaries, as had been the bark, of producing dysentery, liver and spleen enlargement, dropsy; that is, of provoking what was actually caused by the disease itself.[31] It was also accused of changing intermittent into continuous fevers, and later, of course, of producing blackwater fever. Much time also was wasted on the speculation whether quinine was a stimulant or a sedative, and its use at the bedside was made dependent on this kind of sterile philosophy.

The evolution of the attitude towards quinine in the United States closely parallels that in Europe. Quinine was already being manufactured

[27] La Wall, 1931, p. 207.
[28] Webb, 1851.
[29] Groussin, 1831, pp. 11, 15, 16, 19.
[30] Johnson, 1824, I, p. 74.
[31] Coolidge-Lawson, 1856, p. 689.

in 1823 by Farr and Kunzi (later Powers & Weightman) in Philadelphia and sold at $16.00 per ounce. In 1824 G. D. Rosengarten started the production of quinine. It is said that until 1879 (when special duties for quinine were abolished) most of the quinine consumed in the United States was produced in the country.[32] The production was always in the hands of a few manufacturers. As sources of the quinine used in the army during the 30's and 40's the houses of Wetherill; Rosengarten and Denis; Farr, Pelletier, Caventou and Delondré are mentioned.[33] The quinine producing houses in 1879 were Powers and Weightman, Rosengarten & Sons, both Philadelphia, C. T. White & Co., New York.[34] In 1890 the three great quinine producers in this country were Powers and Weightman; Rosengarten & Sons, Philadelphia; New York Quinine Chemical Works Ltd., New York.[35]

T. D. Mitchell seems to have been one of the earliest protagonists of quinine in the United States. In a widely reprinted article in 1846, he refers to his first article in favor of the sulfate of quinine (*Am. Med. Rev. and J.*, 1825). In 1825 Mitchell was a resident of Frankford, Pa. In 1846 he tells how he was opposed on this point not only in the 20's, but at the end of the 30's in Kentucky. Another pioneer of the application of quinine in large doses is Henry Perrine of Natchez. He had given in 1819 large doses of the bark during the paroxysm.[36] In 1826 he published his article on " Fever treated with large doses of Sulphate of Quinine." He gave doses from 8-20 gr. and a total of 64 gr. He used purging and venesection simultaneously. He tried his method on himself and was able to ride horseback two hours after the chill.[37] E. D. Fenner credits rather Perrine, Metcalf and other Natchez doctors with having first (as early as 1823) introduced the treatment with large doses of quinine than the better known Drs. Fearn and Perrin of Alabama.[38]

Fenner states that the North followed in the application of these methods only around 1850. In 1841 Yandell gives the names of Cartwright, Monette, Drake, May, Thomas Fearn (all Southern or Southwestern medical men) as the pioneers of quinine treatment.[39] That the Northwest was hardly behind the South becomes clear from the statements of two

[32] England, 1898.
[33] Coolidge-Lawson, 1856, p. 610.
[34] Transactions, A. M. A., XXX, 1879, p. 35.
[35] Brydon, 1893, p. 22.
[36] Barlett, 1846, p. 391.
[37] Perrine, 1826.
[38] Fenner, 1851, p. 349, pp. 346 ff.; Fearn, 1851, 1836.
[39] Yandell, 1841, p. 196.

Upper Mississippi Valley surgeons: R. C. Wood and J. H. Bailey, who claimed to have used quinine since 1826 and 1825. Wood gave 25 gr. in 12 hours.[40] Dr. Porter of Detroit, treated malaria with quinine in 1828, charging $7.00 an ounce.[41] Dr. Snowden of Philadelphia, used big doses as early as 1825.[42] On the other hand many cases in the 20's were still treated with emetics, blisters, etc., and without use of quinine or bark.[43] T. Flint writes of Missouri:

> The general type of the disorders is bilious . . . Most of the fevers are either remittents or intermittents . . . They are easily managed but are apt to return . . . Their frequent returns, and the course of medicine necessary to check them, soon break down the constitution . . . The two grand remedies, and what almost completes the list of medicines used here, are bark and calomel.[44]

Quinine in the 1830's. The *Dispensatory* of 1834 (p. 990) lists quinine sulfate, 12 gr. of which equal 1 ounce of the bark (a sign that the bark was still in use), recommends 1 gr. of quinine sulfate four times a day, when it was to be used as a tonic, 12-24 gr. of quinine sulfate or 1-4 ounces of the bark in intermittent fever, altogether a fairly adequate dosage and far ahead of what was generally dispensed at that time. The Dispensatories of 1843 and 1851 contain the same instructions. On the other hand a leading American medical authority, Charles Caldwell, strictly denied in 1831 the usefulness of the Peruvian bark in malaria (*Am. J. M. Ph. Sc.*, 1831, p. 339). The leading contemporary authority on malaria for the English speaking world, McCulloch, recommends quinine only at the end of a long list which includes charms and brandy, and with many reservations.[45] The author of another leading textbook, Boisseau (first American translation 1832) accepts eventually in the third edition the replacement of bark by quinine, but " only the blindest empiric can prescribe cinchona in all intermittent fevers." [46] Boisseau prescribes doses from 4-12 gr. He is, of course, still a partisan of bloodletting.

Zeuch reproduces an exceedingly interesting bill of a physician from Whiteside County, Illinois, July 1838 (Benjamin Smith to Dr. Wm. Price), covering a whole attack of malaria.[47] The first 7 days nothing is given but cathartics, emetics, opiates. The seventh day the patient receives 15 gr. of quinine (price $1.00). Then again for 16 days nothing but cathartics, emetics and opiates. Zeuch also reports of the great scarcity

[40] Coolidge-Lawson, 1856, pp. 648, 669.
[41] Buley, 1933, p. 500.
[42] Discussion, 1850, p. 80.
[43] T. Flint, 1826, p. 128.
[44] *Ibid.*, p. 232.
[45] McCulloch, 1830, p. 211.
[46] Boisseau, 1832, pp. 405, 417.
[47] Zeuch, p. 605.

in quinine during a malaria epidemic in DeKalb County in 1839 and how the small supply of the precious drug was reserved for those cases being in a mortal danger.[48] Dr. Chandler in what is now Chandlerville, Illinois, which in 1831 consisted of nothing but Chandler's log cabin, was the first to use quinine in Central Illinois, and opposed heroically the stupid treatment by bleeding.[49] Drs. Winter and Huff of Edgar County, Illinois, gave quinine and calomel by the teaspoonful and still adhered to the classic lancet.[50] Dr. Twyman gave quinine in Charles County, Missouri, all through the 30's.[51] Kremers tells of Dr. Chase who dispensed heroic doses of calomel and very timid doses of quinine in 1835 in Milwaukee when the place had not yet even been incorporated as a village.[52]

In the early 30's Dr. J. Sappington of Missouri began the manufacture and trade of his famous antifever pills which spread all over the West. The active principle of the pills was 1 gr. of quinine. Sappington prescribed 1 gr. every two hours, a rather small dose. He was opposed to large doses.[53]

The *Journal* of Cyrus Sanders of Iowa, quoted already, contains mention of his taking quinine regularly.

The esteem in which quinine (and calomel!) were held in certain localities of the Northwest becomes obvious from the memoirs of F. R. Stebbens. In 1838, during a malaria epidemic in Palmyra, Michigan, the supply of calomel and quinine became exhausted.

> Had our bread failed, our wells and the river dried up, we could have endured it, but to be without cathartic pills and quinine in the fall of 1838 in Palmyra, was worse than a bread and water famine.[54]

In the late 30's and early 40's there occurred an event probably decisive for the general acceptance of an effective quinine therapy in the United States. "The prominent medical feature of the Seminole War was the introduction into the army of giving quinine in large doses."[55] Surgeon C. McCormick from whom we quote these lines adopted during the Seminole War (1835-42) the practice of giving 15-20 gr. at 3 hour intervals; altogether up to 300 gr. in 24 hours. We are rather well informed on this event because in 1843 Surgeon-General Thomas R. Lawson issued a questionnaire on the use of quinine in large doses during the Seminole War.[56] The highly interesting and very detailed answers of 12

[48] *Ibid.*, p. 611.
[49] *Ibid.*, p. 438.
[50] *Ibid.*, p. 377.
[51] Twyman, 1847.
[52] Kremers, 1930, p. 143.
[53] Sappington, 1844, pp. 79, 96, 97.
[54] Burr, 1930, I, p. 686.
[55] This is also the opinion of Churchman, 1906, p. 177 and Kober, 1930, p. 82.
[56] Coolidge-Lawson, 1856, p. 637.

surgeons which form what we would call today a symposium on quinine therapy in 1843, were published in the *Statistical Report on the Sickness and Mortality in the U. S. Army from Jan. 1839 to Jan. 1855, Washington, 1856.* (Abbreviated by us as "Coolidge-Lawson 1856"). As these reports were written in the 40's, they will mostly be quoted under this heading. Although the collection was published only in the 50's, the reports became effective in the 40's, not only because things trickled through, and the "new gospel" was diffused by the ubiquitous army surgeons, but because parts of these reports were already published in extenso in periodicals during the 40's.[57] How things had been in the 30's, in many places and with qualified practitioners, becomes clear from the remark of Surgeon J. J. B. Wright: "Having at that time (1834) no precedent authority for the exhibition of quinine in large doses . . ."[58]

Quinine in the 1840's. In the 40's the opinions on the usefulness of quinine were still very much divided. Nance in a retrospective account of his practice in Lafayette, Stark County, Illinois, in 1845-1846 states that he had no confidence in quinia.[59] T. Barbour was able to write a long article on the treatment of congestive fever (pernicious malaria) in 1841 (*Am. J. M. Sc.*, 1841, pp. 56 ff.) without even mentioning quinine! The Marylander Peregrine Wroth gives quinine only the third place as a remedy for intermittent fever (after bleeding and cathartics), uses it only in the intermission and judges it "most decidedly injurious" in congestive fever.[60]

To Monette, who is even regarded as one of the promoters of quinine, in 1840 quinia is only treatment number six in remittent fever, and then he uses bark instead of quinine.[61] And in the same year he publishes a long article on the dangers of quinine.[62]

Even Drake takes a rather conservative stand on the question of quinine treatment. In simple intermittents he no longer waits with treatment until several paroxysms have passed. He is also opposed to the use of the lancet in most cases, but he still advises, as "preparatory treatment," the cathartics and emetics which are, as he knows, already omitted at this time in many places in the South. On the other hand quinine is to him *the* antidote; he does not insist on a special period of application, although he

[57] *E. g.* Byrnes in *Missouri M. S. J.*, I, 1847, p. 111 ff.; McCormick in *New Orleans M. S. J.*, 1845, p. 290 ff.

[58] Coolidge-Lawson, p. 650.

[59] Nance, 1853, p. 55.

[60] Wroth, 1842, pp. 134, 186.

[61] Monette, 1840, I, p. 126.

[62] Monette, 1840, II, p. 21 ff.

prefers the time shortly before the expected paroxysm. He gives from 1-2 or 5-10 gr.[63] In remittent fever Drake recommends bleeding, cathartics, emetics, diaphoretics, external applications, quinine. This is also the practice of a great number of physicians in Wisconsin, Illinois, Michigan, Ohio, Missouri, Tennessee, Mississippi, Alabama, Louisiana, whom he interviewed on this point in the 40's. Only a small minority had given up or reduced bloodletting and cathartics, and were giving quinine early in the attack. But Drake himself notes that this latter attitude seems to be more and more followed. In so far as doses are mentioned by Drake's informants, they vary between 2 and 10 gr., mostly 5 gr. are given at once.[64] Drake does not believe in the possibility of avoiding relapses by taking quinine during long periods,[65] a practice advocated, for example, by Wood and Potter.[66] The attitude of Clymer, another American authority on fevers during the 40's, is very similar to the one adopted by Drake, in so far as all the traditional measures overshadow quinine. But Clymer gives 10-20 gr. one hour before the expected paroxysm, and does not let the disease run its course for 5 or 6 days, as Prof. Eberle, the author of the well known contemporary textbook on the practice of medicine proposes.[67] Bartlett shows but a very limited attachment to the old methods of bloodletting and purgatives, while he is extremely outspoken and enthusiastic about Cinchona.

He starts his dithyrambus on quinine as follows:

> The periodical element in the pathology of this disease is to be met and neutralized by the great antiperiodic remedy—cinchona and its preparations. There is no substitute for these. They are universally relied upon for this purpose, etc.[68]

Equally enthusiastic is Austin Flint, who deplores that malaria and quinine are too little studied, and who gives without delay, but preferably in the early period of the intermission, 20-30 gr. of quinine.[69] C. Parry equally, in an otherwise indifferent article of the *Am. J. of Med. Sc.*, July, 1843, calls quinine " the master article of the materia medica."

The role of the army surgeons in the introduction of high doses of quinine in the late 30's and early 40's is not only brought out by their own publications in the above mentioned symposium but also by the testimony of contemporaries (e. g. Kober, 1930, pp. 113, 117 on MacCormick and p. 79 on Wright; Fenner, 1851, p. 442). Surgeon J. J. B. Wright,

[63] Drake, II, p. 57 ff.
[64] *Ibid.*, p. 100 ff.
[65] *Ibid.*, p. 132.
[66] Potter, 1849, p. 392.
[67] Clymer, 1846, p. 413.
[68] Bartlett, 1847, p. 384.
[69] Flint, 1841, p. 278.

who changed his opinion under the influence of surgeons Harney and Randall, tells of his very typical attitude in 1840:

> Not yet having met with any notice of the modern practice with the article (quinine), and having as an example of the safety and advantage of its exhibition, during the paroxysm of fever only the solitary case of Captain H., I did not rely upon it as a principal agent, but confined its exhibition principally to the apyrexial period of congestive intermittent and the period of remission in the more continued forms of fever.[70]

Wright came back to the good old notion of the Jesuits, of Cinchona being a specific against malaria, a notion discredited in favor of the sterile philosophizing about its "tonic" or "sedative" character.[71] Surgeon Byrne states in 1843 that many still do not apply quinine in the open inflammatory stage except for congestive fevers. He gave himself 4 gr. every six hours the first day, then 6 gr. every day for five days and thought this to be as efficient as and less dangerous than higher doses. He saw bad effects in a patient who had taken 200 gr. in 10 days.[72] Surgeon R. F. Simpson says:

> I conscientiously believe that, as the prejudice against quinine diminishes, in the same ratio will the sequelae of intermittent and remittent fever disappear.[73]

Surgeon J. H. Bailey declares in 1843:

> I have been tolerably familiar with the use of quinine for the last 18 years. At first the exorbitant price of the remedy together with the cautions promulgated relative to its use prevented myself, as well as many others from prescribing it freely. Gradually the fear of its injurious effects wore off, and the price becoming reduced, the more liberal use became common.[74]

During the 40's in Illinois, Senna salts, quinine and calomel were standard articles and kept in bulk by storekeepers. Especially during the terrible malaria epidemic following the wet summer of 1849, quinine was sold in groceries.[75] Dr. Maury of Mercer County, Illinois, gave in 1845 the following doses: calomel 20 gr., opium 5 gr., quinine 6-20 gr.[76] Drs. Hall and Chamberlain treated in 1846 in Stark County, Illinois, 1500 cases of malaria with 80 ounces of quinine (that is an average of 24 gr. per case).[77]

Missouri medical journals made propaganda for high doses in reporting their use by Graves (10-60 gr.) and Bretonneau (15-20 gr.).[78] Sapping-

[70] Coolidge-Lawson, 1856, p. 651.
[71] *Ibid.*, p. 654.
[72] *Ibid.*, pp. 690, 656, 659.
[73] *Ibid.*, p. 682.
[74] *Ibid.*, p. 669.
[75] Zeuch, pp. 627, 570.
[76] Maury, 1847.
[77] Zeuch, p. 577.
[78] *St. Louis M. S. J.*, IV, 1846, p. 477; *Missouri M. S. J.*, II, pp. 138, 173 ff.

ton quotes a letter of Dr. Lewis to Dr. Mitchell, reporting doses of 50-100 gr. in the Parisian Hospital La Pitié. Dr. Barbour, who in 1841 had still ignored quinine, gave in 1848 calomel and quinine in equal doses of 30 gr. three times a day.[79]

Dr. Elmshorn, Madison, Iowa, reported in 1847 (*St. Louis M. S. J.*, V, p. 237 ff.) an experience of five years during which he had treated 3000 malaria cases with 10 gr. doses every hour (total doses of 40-80 grs.). The *Western Medico-Chirurgical Journal*, Keokuk, 1852, p. 218, commenting on a discussion concerning high doses (35 grs.) in the *New Orleans Medic. Surg. Journal* states that "physicians of the Northwest have used this treatment during the last 6-8 years."

An advertisement of a Milwaukee druggist in the *Milwaukee Sentinel* of 1843 announced the receipt of no less than 200 ounces of quinine.[80] Dr. Ellis of Grand Rapids, Michigan, tried in 1846 to convince Eastern physicians of the usefulness of high doses. He had switched from 1 gr. to 15-25 gr; he was opposed to calomel, brandy and other traditional remedies.[81] Dr. Wilcox of Philadelphia gave the sulfate of quinine in all stages of the disease.[82] Fenner reproduces in the first volume of his *Southern Medical Reports* (1849) excerpts of French and English authors favoring high doses of quinine and opposing calomel. In the second volume of the same publication a report from Lowndesboro, Alabama, attributes the diminution of malaria between 1840 and 1850, to better quinine treatment (p. 333); and Dr. McKee reports: "In the 40's quinine replaced in Middle and North Carolina mercury and the lancet in the treatment of malaria with marked changes (no longer bilious; less pneumonias in winter)" (p. 407). Other Southern contributions to the question of large doses are those of Brickell (1848) and Carter (1846).

Quinine in the 1850's. In the 50's the ice, in so far as the application of quinine and high doses are concerned, seems broken. The "Report on the Epidemics of Ohio" in the 1854 *Transactions* of the A. M. A. (VII, p. 309) states that in the earlier days the treatment with indigenous bitters, mercury, and bloodletting prevailed, "the introduction of quinine in Ohio in 1824 produced an entire revolution in the treatment of autumnal fevers." Because of favorable results doses were soon increased. The A. M. A. *Transactions* of 1855 report for Andrew County, Missouri: "The principal remedial agent in the treatment of intermittent and remittent fevers is quinine." Quinine is given early, in the interval or during remissions

[79] *Missouri M. S. J.*, 1848, p. 47.
[80] Kremers, 1930, p. 143.
[81] Ellis, 1846, p. 64.
[82] *Am. J. M. Sc.*, XIII, 1847, p. 60.

and in large doses.[83] The same report from Chariton County, Missouri: "Active treatment is less resorted to. The use of quinine and morphine is extending in both, medical and domestic practice."[84]

In a very interesting discussion "on the power of quinine in remittent fevers" in the Philadelphia County Medical Society in December 1849, Dr. Isaac Parrish told that while before he had not given quinine in intermittents during the fever, he now used 15-20 gr. with good success. He had learned this technique from the Southern and Western physicians. Dr. Jewell spoke in favor of big doses too, and declared that his lancet had become rusty.[85]

Dr. Knode, St. Louis, also claimed in 1856 that Western and Southern doctors knew more about quinine. He declared bleeding, purging and emetics to be unnecessary; the specific for malaria was quinine. He gave 10-30 gr. at once; and after subsidence of the attacks from 5-10 gr. every seventh day for six weeks.[86] We have already quoted the panegyric on quinine delivered by Prof. Palmer of Detroit, in 1858.

For the 50's again there is ample evidence for self-medication with quinine e. g. from Winona County, Minnesota (1852; *Minn. Med.* 1940, p. 252), from Sangamon County, Illinois in the memoirs of Grierson.[87] Sir William Osler still remembered in 1917 the ringing in his ears, when he was a boy in the 50's, and quinine a household remedy in Southern Canada.[88] Adulteration of quinine is reported too in the 50's (*Western M. Ch. J.*, Keokuk, 1850, p. 55).

Quinine after 1860. The Civil War probably swept away the last hesitations in the use of quinine. The *Transactions* of the A. M. A. of 1870 (XXI, p. 154) give the import of the drug into the Union between 1859 and 1865 as:

Bark:	1,631,876 lbs.	Value:	$1,874,112.00
Quinine salts:	7,526 lbs.	Value:	$ 287,138.00

The Union Army used from 1861-1865:

Sulfate of quinine	595,544 oz.
Sulfate of cinchona	343,286 oz.
Powdered Calisaya bark	259,258 oz.

Churchman estimates that during the war the United States bought 19 tons of quinine sulfate, 9½ tons of sulfate of cinchona.[89] The South too

[83] Reyburn, 1855, p. 143.
[84] *Ibid.*, p. 136.
[85] Discussion, 1850, pp. 78, 80.
[86] Knode, 1856, p. 411.
[87] Grierson, 1909, p. 54.
[88] Osler, 1917, p. 621.
[89] Churchman, 1906, p. 180.

consumed enormous amounts of quinine, which cannot be estimated because of the blockade conditions.

The general use of quinine in civilian households in the 1860's and 70's is graphically described by Burr.[90] Quinine was generally used in Missouri during the 70's.[91] Barber gives the following description for Western Missouri in the 60's and 70's.

> Quinine in large bottles stood on the clock shelf of every home in the 'bottom' lands, together with a tumbler of water containing slippery elm bark. In some families quinine taking was a daily ritual—not as a preventive, because the people were so rarely free from malaria that there was no question of anything but cure.[92]

Economic Aspects of Quinine Consumption

Not only the prejudices of doctors and laymen retarded the proper use of quinine. A still greater obstacle was the price of quinine, fabulous in the beginning, and too high for the poor up to this day.[1] According to Buley quinine was rarely used before 1830 because of its price.[2] In the Symposium of Military Surgeons of 1843 there are no less than four statements that poor people did not use quinine at all, or in small doses because of the price.[3]

We have abstracted from a complete list of prices per ounce from 1823 to 1897 the following data given by England:[4]

TABLE 8

Quinine Prices from 1823-1897

1823	$16.00	$20.00	1870	$2.20	$2.40
1830	1.75	2.50	1873	2.40	2.50
1833	1.70	1.87	1880	2.20	3.20
1840	2.87	3.12	1883	1.60	1.80
1843	1.55	1.80	1884	.90	1.80
1850	3.70	3.70	1887	.46	.70
1853	2.70	3.20	1890	.39	.42
1860	1.20	1.80	1893	.29	.32
1863	2.70	3.20	1897	.24	.37

[90] Burr, 1930, p. 681.
[91] Pryor, 1943, p. 70.
[92] Barber, 1930, p. 8.
[1] Mal. Comm., 1927, p. 70.
[2] Buley, 1933, p. 500.
[3] Coolidge-Lawson, 1856, pp. 674, 678, 682, 669; see also Zeuch, p. 200; Knode, 1856, p. 411.
[4] England, 1898, p. 60.

But this table leads to a rather optimistic idea of the actual retail prices. Corson gives the price per ounce in 1825 as $26.00, in 1826, as $16.00.[5] Buley tells that in Indiana in 1830 quinine sold at $30.00 an ounce, in 1846, $6.00 to $8.00 an ounce.[6] While the quinine price in 1913 was down to $.25 an ounce, in 1939 it was up again to $1.25. The monopoly of a few manufacturers of quinine during the Civil War and the enormous profits they realized made the abolition of the duties on quinine in 1879 popular. They had oscillated between 15 and 45 per cent from 1832 to 1878.[7] Together with the increase in bark production in Java and India this lowered the prices for quinine and favored its consumption considerably. A look at even England's benevolent table shows why malaria is to such a large extent an economic problem and that up to the 80's quinine in sufficient quantities was financially out of the reach of a great part of the population.

The high prices for quinine and its difficult accessibility in time of war have kept alive the search for substitutes practically since the bark came into use. Quinine was substituted in the United States by native herbs and roots, e. g. prairie dock, especially when the provisions ran out.[8] The 50's and 60's seem to have been a period of particular activity in testing native drugs. S. Pollak of Missouri, a staunch supporter of quinine, reports on such experiences in the *Transactions* of the A. M. A., VIII, 1854, p. 261. The Civil War further stimulated these attempts. In 40 medical journals we find traces of this search for quinine substitutes. The most systematic work in the field is a series of articles published by Dr. J. Jones in the *St. Louis Medical Reporter* of 1868, discussing no less than 37 native plants.

Other fruitless attempts to lower the price of malaria treatment by using other alkaloids of the bark than quinine, e. g. cinchonia or cinchonidia, were made repeatedly.[9]

From 1864 to 1875 the American Medical Association led a vigorous but unsuccessful campaign for the cultivation of the Cinchona tree in the United States with which we have dealt elsewhere in greater detail.[10] Modern investigators assert that the tree cannot be grown in any part of the United States.

[5] Corson, 1888, p. 3.
[6] Buley, 1933, p. 500.
[7] Churchman, 1906, p. 180.
[8] Zeuch, p. 579, see also the already mentioned herb doctors, Johnson and Rooks, Zeuch, p. 352.
[9] Hinkle, 1857, Powers & Weightman, 1876.
[10] Ackerknecht, 1943.

In spite of the high prices, the quinine consumption of the United States was truly enormous during the second half of the 19th century. Robbins estimates the world consumption in 1888 as being 6-7 million ounces and states that four-tenths of this quantity was consumed in the United States.[11] Brydon estimates the average annual consumption of the United States in 1895 (population, 69,000,000) as being 3,500,000 ounces.[12] In 1940 (population, 131,600,000) the annual consumption was still 5,000,000 ounces per year.[13] England (p. 63) gives the following data on quinine and bark import in the United States between 1870 and 1879:

TABLE 9

Importation of Bark and Quinine

	Pounds of bark	Value	Ounces of Quinine Sulfate	Value	Population
1870	1,490,000	$ 399,496.00	37,550	$ 36,767.00	38,500,000
1880	6,103,877	1,679,472.00	416,998	1,111,254.00	50,100,000
1890	2,838,306	282,737.00	2,990,239	886,430.00	62,900,000
1897	2,537,693	142,303.00	2,714,147	489,821.00	75,900,000

All these data, of course, do not answer the question most important for our problem of malaria decrease: how many malarious people took how much quinine in the Upper Mississippi Valley in the second half of the 19th century, a question to which we will have to return.

The End of Bloodletting and Purging

I have already mentioned that in the minds of the majority of doctors the bark, and later quinine, was only one element in the treatment of malaria, and often only the least important, while the murderous bleeding, purging and emetics, ruled sovereign. I have occasionally mentioned promoters as well as adversaries of these methods in my documentation on the use of quinine; but the disappearance of bleeding and purging is so closely linked with the introduction of rational methods in the use of quinine and the treatment of malaria, that it seems necessary to give some complementary data on this subject.

Churchman thinks that one of the medical lessons of the Seminole War was not only the use of high doses of quinine, but also the abandonment of

[11] Robbins, 1888.
[12] Brydon, 1895.
[13] Moulton, 1941, p. 255.

bleeding, while the use of cathartics continued.[1] This opinion seems to us highly optimistic. It is true that during the 30's the voices of the adversaries of both practices became louder and more numerous, and that locally sometimes "mercury and lancet were replaced by quinine."[2] But we have seen how even promoters of quinine in the 30's like Drs. Chase, Winter, Huff; in the 40's men like Drake, Monette, Hall, Chamberlain, Maury, not to speak of P. Wroth or Barbour, closely adhered to the old methods. Particularly interesting is the statement in 1846 of Clymer, who personally was against calomel and for bleeding, that the latter method had rather increased during the last decade.[3]

Dr. E. H. Gregory says in Goldstein's history of medicine in Missouri:

> Bleeding was popular until 1850, not so popular in the later years . . . They had learned the use of quinine as it is used today. Quinine was used to prevent a fever but not to effect a cure. Calomel was the main drug . . . The first to use quinine was Dr. Sappington.[4]

We have already quoted from the report on Missouri in the A. M. A. *Transactions* of 1855 that "active treatment is less resorted to" [this means bleeding and purging, E. A.]. A remark of the lawyer, C. C. Andrews of 1856 reveals also the declining respect for bleeding among the laymen:

> Special pleading has been laid on the shelf about as effectually as bleeding in the practice of medicine.[5]

But as far as purging is concerned, it was recommended in malaria as late as 1884 by an otherwise very modern physician as G. M. Sternberg.[6] According to the *Transactions* of the Missouri Medical Society in 1886, 18 out of 37 physicians still used the "preparatory treatment" (giving otherwise 20-40 gr. of quinine).[7] Very graphic are also the following boyhood recollections of J. Henderson, a playmate of the Flexner brothers during the 80's in Louisville, Kentucky, a place with a rather brilliant medical past:

> Whenever we seemed at all unwell we received immediately ten grains of quinine with calomel in powder form on the point of a knife. Some of the older people had lost their teeth from being salivated with excessive doses of calomel: this was so common that we children used the word "salivate" as a slang synonym for administering a crushing defeat.[8]

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[1] Churchman, 1906, p. 177.
[2] McKee in Fenner, 1851, p. 407.
[3] Clymer, 1846, pp. 406, 441.
[4] Goldstein, 1900, p. 39.
[5] Andrews, 1856, p. 44.
[6] Sternberg, 1884, p. 189.
[7] Hart, 1886, p. 52.
[8] Henderson, 1943, p. 25.

Surgeon James Mann protested against the abuses of calomel and emetics as early as 1816.[9]

One of the first to do away altogether with these horrors was undoubtedly Dr. Plumbe of Dubuque, Iowa, a graduate of the University of Leyden who cured in the 1830's after the "European plan" without a single grain of calomel.[10] In 1832 the New Orleans sanitarian Edward Hall Barton violently attacked the habits of bleeding and purging.[11] Here also lies the real merit of Dr. Sappington of Missouri, who vigorously opposed "depletion." In all justice it must be said that the different sectarians, the Thomsonians for example, were among the first and most violent fighters against the lancet and calomel, and brought thus strong pressure upon the profession.[12] We have already mentioned Dr. Chambers of Illinois, as another pioneer in the battle for the introduction of quinine and the elimination of bleeding in the 30's. Drake's and Bartlett's opposition in the 40's was rather half-hearted, but very outspoken for quinine and against the preparatory treatment were Drs. Boling (Alabama)[13] and J. Ellis (Michigan).[14] We have also already quoted identical opinions of Drs. Parrish and Jewell (Philadelphia) in 1850.[15] Dr. Armor (Iowa) equally opposed purging in 1852,[16] and Dr. Knode (St. Louis) attacked the whole unholy triad: bleeding, purging, emetics.[17] But this proves that there was still something to oppose. The mercurialists tried to defend their position with the argument that the bad diet of the West made necessary the use of abnormal quantities of calomel.[18] Dr. Pryor thinks even that his father was one of the first to abandon bloodletting and purging in malaria in Palmyra, Missouri. And that was in the 1870's![19]

In the 90's, it is true, Osler could write in Allbutt's *System of Medicine* (vol. II, p. 739):

"*Treatment*: This is comprised in one word, quinine."

The loss of teeth from calomel medication mentioned by Henderson above seems to have been quite a common phenomenon at the frontier.[20] True mercury poisoning from treatment during malaria epidemics seems

[9] Mann, 1816, pp. 80, 88.
[10] Petersen, Doctors, 1938, p. 403.
[11] E. H. Barton, *The Application of Physiological Medicine to the Diseases of Louisiana.* Philadelphia, 1832.
[12] Thomson, 1826.
[13] *St. Louis M. S. J.*, IV, 1846, pp. 225 ff.
[14] Ellis, 1846, pp. 64 ff.
[15] Discussion, 1850, p. 80.
[16] Armor, 1852.
[17] Knode, 1856, p. 411.
[18] Curtis, 1852.
[19] Pryor, 1943.
[20] Burr, 1930, p. 686.

not to have been a rarity.[21] As these measures were after all propagated by doctors, it is extremely doubtful, whether the lack of doctors on the frontier, if it ever existed (see p. 10), was really a negative influence in shaping the health situation. Our material seems to bring out that the decline of "preparatory" or "active treatment" assumed considerable proportions only in the 50's and even then was slow enough. We must renounce dealing here with the numerous other more or less useless methods of treatment, as their number is too large and their relative importance too small. But we would like to remind our readers at least that the famous "Fowler's solution" was originally an ague tincture,[22] and used as such in this country as late as the 40's.[23]

Self-Medication and Patent Medicines

The history of quinine in the Upper Mississippi Valley would be highly incomplete without giving special mention to self-medication and patent medicines. As a matter of fact we have come across them repeatedly in the foregoing chapters, in the 30's as well as in the 40's, in Illinois and Iowa as well as in Missouri, Wisconsin and Minnesota. It was inevitable under pioneer conditions that self-medication in all its variations should play a great, if not the dominant role in the treatment of malaria. *While quinine consumption under medical control, its dosage and efficacy, can probably at least approximately be estimated, this is unfortunately impossible for the main consumption of quinine in household medication, nostrums, etc., which have no history.* This difficulty still exists. Dr. Justin L. Powers, Chairman, Committee on National Formulary of the Americal Pharmaceutical Association, Washington, was kind enough to inform me:

> Even if this information (distribution of quinine in certain sections of the U. S.) were available it would mean very little for our purposes. Prior to the war, large quantities of Quinine were used in proprietory cold preparations and in the form of various salts by the public, without the benefit of advice from physicians.

Self-medication of quinine took the most various forms. Its widespread use in the 40's is mentioned by Twyman (1847) and Bartlett (1847, p. 392; doses from 1-2 and 8-10 gr.). Bierring tells us that Dr. Isaac Galland, the father of the first white child born in Iowa (1830), sold a medicine chest, "Dr. Isaac Galland's Family Medicines," containing the

[21] Zeuch, p. 568.
[22] Currie, 1811, p. 30.
[23] Clymer, 1846, p. 411.

usual and ordinary remedies and placed in nearly every cabin in his wide field of practice.[1]

From self-medication to the use of mysterious patent medicines there was but one step and thanks to the advertising genius of the American quack, it was taken more often than not. The perusal of early American and Western newspapers gives rich illustrations to this subject. Gruel states that in 1868 (!) many people were still afraid of quinine or disliked its taste. Thus they took it in smaller doses but for higher prices and very often combined with alcohol in the form of patent medicines. There were in 1868 about 50 brands of patent medicines on the market containing quinine in spite of the affirmations to the contrary printed on the label. Besides as efficient "household remedies were used coffee with lemon guill, whisky with capsicum, vinegar with the white of the egg, solutions of ordinary salt; and even spider's webs, burned eggshells, gunpowder, and infusions of Radix verbenae salicifoliae."[2] Hektoen reproduces some of the juiciest advertisements of patent medicines in the first Norwegian American newspapers around 1850. (Fever and ague medicines, Halloway's Pills, Ayer's Pills, Dr. David Chayne's Family remedies, etc., etc.). Great popularity was enjoyed in Illinois by Dr. Cyrenius Wakefield's "famous treatment for chill and fever," Dr. J. Sappington's "Anti-fever pills," "Roman's Tonic Mixture," "Indian Chocalogue" (Cholagogue), etc.[3] On the market were also "Ring's Remedy guaranteed to cure fever and ague," "Rowand's Tonic Mixture," "Henry's invigorating cordials," "Prof. (?) Morse's invigorating cordial," "Hoofland's German Bitters," etc. Austin Flint (1841) and Potter (1849) relate that the prejudice against quinine, prevalent throughout all malarial regions, was diligently promoted by the nostrum manufacturers, these jackals, preying on the ignorance and despair of the disease-ridden pioneer. The trick of abusing quinine publicly while using it secretly was not new, having been applied successfully by the Hon. Dr. R. Talbor in the 17th century. It is difficult to judge to what extent these bitters, tonics, etc., were efficient. Today they have to contain a minimum dosage of 16 gr. per day over a period of eight weeks.[4] But in our period there was no Food and Drug Control Board or Laws.

Dr. C. A. Harper says:

In those days (1860's) it was customary to give quinine in whisky, usually prescribed a certain number of times a day, say three or four, after meals and bedtime,

[1] Bierring, 1926, p. 7.
[2] Gruel, 1868, p. 30.
[3] Zeuch, pp. 477, 537, 603, 627.
[4] 300th Anniversary, St. Louis, 1931, p. 15.

but of course the doses must have been limited because none of such treatment prevented the chills and fever.[5]

Prof. LeBlanc writes:

That quinine eliminated much malaria is open to doubt. In the first place the vast majority of the so-called 'chill-tonics' used by the people in this area against malaria contained too little quinine so that when they were used *in the dosages recommended*, they were not therapeutically active.[6]

There seems to have been on the other hand a category of citizens who for extramedical reasons and because of a pronounced interest in the solvent in which the drug was suspended, transgressed the recommended dosages, and thus, under the pious label of medicine not only enjoyed the otherwise ostracized custom of tippling, but also got sufficient quinine into their systems. How large was this category to which Prof. LeBlanc drew my attention is, of course, impossible to determine. That it was not altogether rare appears from the following remark of Dr. Nichols (1861):

The temperance reform, making it immoral and unfashionable to drink liquors, except as medicine, made the fortune of the manufacturers of stomachic bitters and aromatic Schiedam schnaps, highly recommended by well fed members of the faculty.[7]

Undoubtedly one of the best known and most widely diffused patent medicines in the South and West of the 1830's were Dr. J. Sappington's Anti-Fever Pills which contained 1 gr. of quinine. We find their traces in Illinois, Iowa, Missouri, Arkansas, Tennessee, Michigan, Ohio, Indiana, Alabama, Mississippi, Louisiana and Texas. There would be no special reason to talk more of this patent medicine than of any other, were it not for the attempts, sometimes even by serious authors who combined most excellent studies of 19th century malaria with the most uncritical appraisal of Sappington, to make out of Sappington a kind of mid-Western culture hero. He is depicted as e. g. the "champion of quinine in the South and West," a kind of Gorgas "who brought into use the quinine treatment in the States of the Mississippi Valley," as a "great humanitarian," a man "of clear insight of disease and far ahead of his time in many respects," and eventually a victim of the snobbery and jealousy of his professional brethren.[8] We have studied the available sources and have come to the following conclusions in so far as these assertions are concerned:

[5] Personal communication of Dr. Harper.
[6] Personal communication of Prof. LeBlanc.
[7] Nichols, 1937, p. 227.
[8] E. g. Hall, 1930; Terry, 1930.

1. Sappington was neither the first nor the only one to use quinine in the Mississippi Valley in the 30's as our historical sketch has already shown. And he distributed it as a *patent-medicine*. He gave the secret of his pills away only in 1844, when the use of quinine had been already spread far and wide by the courage, insight and unselfishness of others than himself.
2. His stand against depletion was a real medical merit. But even in this field he was neither the first nor was he alone, as our studies have already shown. In so far as his " clear insight " is concerned, one has but to read his mediocre book, to be enlightened concerning this point. We would not even hold against him the fact that he still held to the idea of the " unity of fevers " and used quinine not as a specific, but as a panacea against typhoid, typhus, measles, puerperal fever, cholera, cholera infantum.[9] Better medical men than he did so in the same period.[10] Sedgewick of Little Rock, Illinois, fabricated even a theory that every disease in the West needed " tonics " (quinine), because " everything there has a touch of ague." [11] But Sappington's arguments in general are very poor and his doses of quinine were extremely small. The best one can possibly say of Sappington as a medical man is that he was better than a lot of his colleagues and not worse than most of them.
3. His declaration that he sold quinine as a secret remedy for " humanitarian " reasons is generally taken at face value. We are wicked enough to think that to a man so much involved in the trade with mules, slaves, land claims, etc., the fact that he could sell at the handsome price of $1.50 a product which cannot have cost him more than $0.10 meant more than a lot of " humanitarian " arguments. Sappington's praised " humanitarian " act of finally disclosing his secret after 12 years of successful trading is also more easily explained by sound business than by humanitarian reasons. In a letter of December 21, 1842, his agent R. L. Watkins, Mobile, informs him of the decline in the sale of his pills.[12] " Quinine is now the article most resorted to in the treatment of ague and fever. No patent medicine sustains itself more than 2 or 3 years." It seems thus that

[9] Sappington, 1844, pp. 153, 163, 173, 179, 215, 115.

[10] E. g. Surgeon General Thomas Lawson; see Sappington, p. 136; see also Palmer, 1858; *St. Louis M. S. J.*, 1856, p. 173.

[11] Sedgwick, 1849, p. 31.

[12] All Sappington letters, quoted here, are in the Archives of the Historical Society of the State of Missouri, Columbia, Mo.

by publishing his book in 1844 Sappington had no longer anything to lose and a great deal to win by the liquidation of his stocks. As a matter of fact the book served as a prospectus for these stocks, and was sold together with the pills (Letter of agent J. B. Hogue, Aug. 22, 1848).

4. It is a simple matter of fact that Sappington was not ostracized by his colleagues. After all he made a lot of money, which always inspires respect in the majority, and the medical profession was accustomed to this kind of authorized quack in this period. Their benevolence towards Sappington is clear from Dr. Gregory's contribution to Goldstein's *Medical History of Missouri*; a review of Sappington's book in the *St. Louis M. S. J.*, II, 1844, p. 83, and a letter of W. Price (Philadelphia, Feb. 4, 1846) reporting a friendly attitude of Prof. Mitchell.

Sappington was certainly a very interesting and colorful personality, a great business man with a lot of common sense, a kind of 19th century provincial R. Talbor. But four things he most likely was not: the promoter of quinine in the Mississippi Valley, a great doctor, a great humanitarian or a misunderstood genius.

Quinine Prophylaxis

While the therapeutic value of quinine has not been questioned for almost a hundred years, opinions concerning its prophylactic value still vary widely. It is generally supposed that Cinchona prophylaxis started about a hundred years ago.[1] But while this may be correct in so far as the more widespread application of the prophylaxis is concerned, it had its forerunner much earlier. The Chevalier de Bourneval seems to have given bark prophylactically at the siege of Belgrad in 1717.[2] James Lind prescribed it in great detail in 1765 (every morning a wineglass of the infusion of the bark or a tablespoonful of the tincture).[3] Scott credits Sir Gilbert Blane with the introduction of this measure,[4] and thus follows the usual custom of honoring Lind, the father of naval medicine, by giving credit for his achievements to his knighted imitator.[5] Ross dates back the preventive use of quinine to Maillot of Algeria, one of the greatest malariologists of all times, who undoubtedly was an enthusiastic promoter of the

[1] Scott, I, p. 235.
[2] Trabaud, 1924, p. 116.
[3] Lind, 1808, p. 318.
[4] Scott, I, p. 34.
[5] Ackerknecht, 1942.

custom.[6] Quinine had at that time two strong competitors as prophylactic drugs: coffee and whiskey. The lesser suffering of the French from malaria in the Upper Mississippi Valley had even been explained by the fact that they were coffee and not tea drinkers. Drake disproved this explanation as well as both methods.[7] But strangely enough Sternberg recommends coffee as prophylacticum as late as 1884![8] One wonders whether this supposed virtue of coffee was not instrumental in converting the Americans from tea to coffee drinking.

One of the earliest promoters of the preventive use of quinine in the United States was undoubtedly Sappington, who recommended to his agents the taking of 3-4 gr. a day while traveling in malarious regions.[9] Boyd quotes Merritt (1850) and DeSaussure (1860) as other North Americans recommending the procedure.[10] A considerable increase not only of the literature on quinine prophylaxis but of the custom itself was brought about undoubtedly by the Civil War. Prophylactic quinine was recommended in W. H. Van Buren's *Rules for Preserving the Health of the Soldier* (1861). The question was more elaborated in a special pamphlet (Doc. D) of the U. S. Sanitary Commission: *Quinine as a Prophylactic Agent against Malarious Diseases* (1862). Surgeon Rogers, who, like Merritt, had made his first experiences with quinine prophylaxis in Panama, published a brochure in favor of it in 1863. He prescribed 4 gr. twice a day.[11] Quinine prophylaxis was equally recommended in the Confederate Camp (see an article of J. Jones, *South. M. S. J.*, Augusta, N. S. XVII, 1861, pp. 593-614).

In so far as preventive use among civilians in the 60's is concerned, we have already come across Vaughan's father who still took bark. Gruel reports on quinine prophylaxis in the United States in the 60's, but personally regards it as inefficient.[12] Dr. Derby pleads for the prophylactic use of quinine in the *Boston M. S. J.* of 1863. The *Transactions* of the A. M. A. of 1869 deal repeatedly with the subject. Rogers reports having used the method since 1851 on suggestions from medical journals which he does not specify.[13] Herrick of Louisiana, in his prize essay on quinine, tells of quinine prophylaxis in Africa and during the Crimean War.[14] The A. M. A. in its petition to congress for the cultivation of the Cinchona tree in 1870 emphasizes the prophylactic value of quinine, referring to the

[6] Ross, 1910, p. 43.
[7] Drake, I, pp. 660, 668.
[8] Sternberg, 1884, p. 120.
[9] Sappington, 1844, p. 85.
[10] Boyd, Symposium, 1941, p. 5.
[11] Sternberg, 1884, p. 121.
[12] Gruel, 1868, p. 26.
[13] Rogers, 1869, p. 187.
[14] Herrick, 1869, p. 617.

above mentioned monograph of the U. S. Sanitary Commission.[15] In spite of this strong trend in favor of quinine prophylaxis not all data on the regular intake of quinine should be interpreted in this sense. Burr states expressly: "There was actual invasion—the chill—before medication was given. I cannot remember that quinine was ever prescribed in my boyhood days for prophylactic reasons alone."[16] And Barber says: "In some families quinine taking was a daily ritual—not as a preventive because the people were so rarely free from malaria, that there was no question of anything but cure."[17] Sternberg in his authoritative essay was in favor of quinine prophylaxis.[18] The existence of prophylaxis seems thus fairly well established. I have already recorded a few other opinions on this point, and abstain from a more detailed discussion for, as Scott says: "There is nothing to be gained by recording the varying opinions since that time concerning the value of quinine prophylaxis. They all vary."[19] There were opinions like the one of Dr. Angus MacDonald. "Quinine has its position in relief and cure but in sanitary administration it has none." Or like the one of Dr. C. F. Hartford: "There is good cause for advocating the use of a daily dose of quinine of five grains, which has in the past produced most important results."[19] There were good results, especially when quinine was combined with other measures as for instance in Italy,[20] and there were mass experiments like those of Stott, which gave absolutely negative results.[21] Even opinions concerning the Macedonian campaign of 1916-1918 which generally very much lowered confidence in quinine prophylaxis, were divided. Divided was the International Congress on Malaria in 1930 (*J. A. M. A.*, Aug. 23, 1930), etc., etc.,

The most equitable statement seems to be that of the Malaria Commission of the League of Nations:

> *Prophylactic Use of Quinine*: Quinine does not prevent infection, but, taken over a sufficient period of time and in appropriate doses, it can often prevent the appearance of symptoms of infection and enables the organism to rid itself of parasites.[22]

Therefore quinine prophylaxis has its limited value for explorers, for road builders in the jungle and particularly for armies, where the important thing is to fulfill a certain task in a given time—quinine suppressing the clinical symptoms may often help to obtain this goal—and where the anatomical question of infection and how many may fall sick once the task

[15] Trans. A. M. A. XXI, 1871, p. 154.
[16] Burr, 1930, p. 681.
[17] Barber, 1930, p. 8.
[18] Sternberg, 1884, p. 109.
[19] Hoffman, 1917, p. 43.
[20] Grotjahn, 1923, p. 95.
[21] Stott, 1916.
[22] Mal. Comm., 1927, p. 73.

is fulfilled may be of secondary importance. But in so far as communities are concerned the role of quinine seems restricted to treating the attacks and the dictum of P. F. Russell seems justified:

> There is still no drug which is sufficiently effective to justify the use of chemoprophylaxis to eradicate malaria from communities.[23]

Quinine: Summary and Conclusion

It seems to follow from the material submitted above that quinine treatment was introduced into the old West in the 1820's, but that it did not achieve general recognition and a dosage which we would judge adequate today until the 40's. It seems that in this field the old West and South were rather in advance as compared to the Northeast. A rapid fall of quinine prices in the 80's increased greatly the use of quinine. Bloodletting and purging were first abandoned on a large scale in the 50's, but faded out only slowly. Patent medicines somewhat declined with the official recognition of quinine in the 40's, but hold their own up to the end of the century. The prophylactic use of quinine started in the United States in the 50's and spread wide in the 60's.

The appraisal of the doses of quinine given in the 1820's and 30's is, of course, a very delicate question, as " quinine is a drug which physicians have used for 300 years without coming to any consensus of opinion as to proper dosage, method of administration, length of treatment, pharmacological action, effective results, or prophylactic value, either individually or socially." [1] Or as C. C. Bass termed it: " There are almost as many methods of treating malaria with quinine as there are authorities on the subject." Older opinions, as the one of Page of Wisconsin in 1871, that in some districts larger and more frequent doses will be required than in others, no longer sound foolish to us,[2] since we have learned that different strains of the same plasmodium need quite different doses, and we therefore do need not general but local standard treatments.[3] However, in the rare cases where we can actually find out approximately how much quinine a patient was given—as in the case of Drs. Hall and Chamberlain, Stark County, Illinois, where the average quantity consumed in one summer was 24 gr. per patient, or where we estimate doses supposing that physicians acted according to textbooks—we can safely state that for decades the average total quantity and the average dosage was indeed too small com-

[23] P. Russell, 1943, p. 624.
[1] Hackett, 1937, p. 177.
[2] Page, 1871, p. 51.
[3] Hackett, 1937, p. 186.

pared to earlier as well as to later standards. The Jesuits gave the equivalent of 12 gr. of quinine in bark at once; Sydenham gave the equivalent of 4 gr. of quinine 12 times every 4 hours.[4] A total treatment according to the standards of the League of Nations would need 20 gm. (300 gr.) per year;[5] according to the standards of the National Malaria Commission even 44 gm. (660 gr.).[6] According to Dawson at least 10 gr. on two subsequent days are needed to obtain a positive effect.[7]

But even admitting that for a number of years quinine doses were too small, we do not feel certain that this always and everywhere influenced the malaria situation in an absolutely unfavorable manner. We know now that quinine has a retarding effect on the development of immunity.[8] But in a highly hyperendemic region where no other improvements are made the building up of an immunity is in the long run perhaps much more important than the effective treatment of one single attack. For the same immunological reasons, the prescription to give quinine not too early, made by Sydenham, and found with our earlier authors, was, in the special setting of these periods, perhaps not as bad as for a long time it was thought to be.[9]

It is extremely difficult on the basis of the scanty material at our disposal, to give a judgment on the rôle which quinine played in the disappearance of malaria from the Upper Mississippi Valley. We have not even the meagre data we disposed of e. g. for drainage, cattle breeding, etc. Generally speaking it is absolutely clear that a country can rid itself of malaria without any quinine. Rome did so three times between 200 B. C. and 1500 A. D. Experimentally it has been shown especially by the 10-year experiment of Clark and Komp in Panama, alluded to already by Prof. LeBlanc, that drug control alone is unable to drive out malaria; and the percentage of heavy cases even increases.[10]

But all this does not answer our specific question: what rôle did quinine play in the 19th century in the Upper Mississippi Valley? The right answer is not to be found in assumed but non-existent special merits of quinine. Quinine does not avoid infection; quinine does not sterilize the carrier. Quinine, therefore, cannot have a direct effect on the eradication of malaria from a community. Whoever tries to link quinine directly with the disappearance of malaria because quinine is the most direct anti-

[4] Scott, I, p. 234.
[5] League of Nations, 1932, p. 9.
[6] Moulton Symp., 1941, p. 258.
[7] Dawson, 1930, p. 128.
[8] Moulton Symp., 1941, p. 238.
[9] Hackett, p. 185.
[10] Clark and Komp, 1941, p. 279.

malarial measure, is pleading a lost cause, because he is pleading against the evidence. But quinine does have one quality which nobody denies and which may be decisive in certain historical situations: it stops the clinical attack, it makes people fit to fight and to work, when without quinine they would not be able to do so.

Now, the eradication of malaria from the Upper Mississippi Valley was to a large extent the work of indirect measures undertaken without sanitary intentions: better agricultural methods, cattle breeding, better housing, screening, more prosperity, education, etc. But it is most likely that this progress was only realized, and only realized so quickly, because of the help of quinine. Quinine kept the " invasion army " of the settlers fighting in a decisive period. Quinine broke the vicious circle of disease-producing inactivity, and inactivity conserving the sources of the disease. Quinine, the " direct antimalarial " paradoxically enough acted in the most indirect way: in making possible the indirect, unconscious socio-economic achievements. Without quinine the economic development of the whole region and therewith the decline of malaria would most probably have been at least considerably retarded.

Climate and Weather

Malaria is closely associated with a number of climatic conditions. The *Anopheles* and its larvae need a certain temperature to grow, live and be active. The malaria parasite likewise needs during two weeks a minimum temperature for its proper development in the *Anopheles*. In the latitudes of the Upper Mississippi Valley the part of the year during which all these necessary climatic conditions are given is relatively short. There is no possibility of continuous breeding of the *Anopheles*, nor of continuous reinfection of the human host as it exists in the tropics. Williams has therefore rightly emphasized the temperate climate of the Northern United States with its short transmission season as the fundamental condition for the automatic removal of malaria brought about according to him by drainage and screening.[1] Barber has pointed to the importance of the winter from another angle: " The longer winters of the North may have afforded sufficient respite from the disease to permit of the annual recuperation of people." [2] Riley gives the situation of Minnesota between the summer isotherms 65-60 as the main reason for the absence of malaria in spite of the presence of *Anopheles*.[3] According to Boyd: " The summer

[1] Williams, 1941, p. 364. [2] Barber, 1930, p. 8. [3] Riley, 1939, p. 312.

isotherm of 60° F. affords a closer limit of the potentially malarious regions than does either latitude or altitude alone." [4] The Upper Mississippi Valley being placed mainly between the summer isotherms of 65° and 75° F. comes thus in large parts pretty close to the northern limits of malariousness, and this certainly made the decline of malaria much easier than in more southern regions. Important as this factor is, it should, on the other hand, not be too much isolated and overstressed, as the history of malaria not only in New England and Canada but especially in Northern Europe (Holland) and in Northern Russia shows that malaria, even under climatically unfavorable conditions, can get a firm grip on such inhospitable regions, other factors for its disappearance being absent.

The influence of weather (wet springs, hot summers, cold summers) on malaria incidence in a given year is so well known and has been shown so often in the earliest statistics,[5] that it is quite unnecessary to treat this point here in detail, all the more as it has no bearing on our special problem. What we had to examine was whether a series of dry or wet, hot or cold years had any relation to the decline of malaria, either in the sense of speeding up or retarding such decline. Careful perusal of weather records since the 40's in the states of Minnesota, Missouri, and Illinois has not shown any significant relation between the two phenomena.[6]

As we had to limit our examination of the history of malaria in the different states to the essential points, disregarding the finer epidemiological oscillations of the malaria curve, thus we have also to limit our study of the possible factors of malaria disappearance to those which seemed most important in the region under examination. Since we know that the " best " carriers are babies and small children, it is quite possible that for other regions and countries birth control, which restricts the foci of infection in time and space, may be an important factor in the decline of malaria.[7] An examination of this (and other points) seemed unnecessary for our region, as malaria decline there was prior to birth control. In examining such points as the possible diminution of the virulence of the parasites, we are limited by the existence or non-existence of records. To think that such a study could or should " discover " new factors would be to misunderstand its tasks and its possibilities; we can only check, on the basis of historical and statistical records, such factors as have been signalized by the clinician, the field worker and the experimentalist.

[4] Boyd, 1930, p. 15.
[5] E. g. Forry, 1841, p. 43.
[6] H. Clayton: *World Weather Records*, Smiths. Misc. Coll., vol. 79, Washington, 1927.
[7] Hackett, 1937, p. 70.

Possible Factors: Summary and Conclusion

Summarizing our results with reference to the rôle of different factors in the decline and disappearance of malaria from the Upper Mississippi Valley, it may be stated that the arrest of population movements was of considerable importance generally, and that even on the basis of very crude statistics relations can be established between a sudden drop in population increase and the decline of malaria for Missouri, Iowa and Wisconsin.

In so far as the shifting of settlements from watercourses inland, symbolized by the installation of railroads, is concerned, the data of malaria decline and railroad building show such close coordination for all states that the importance of this factor can hardly be doubted.

There is no possibility of measuring the amount and effect of individual and local drainage. The operation of organized drainage enterprises occurs so late that in Iowa, Wisconsin, and Minnesota not only the decline but also the disappearance of malaria precede it. In Illinois and Missouri also, malaria decline antedates by decades organized drainage enterprises which nevertheless may have contributed to the speeding up of the process of disappearance, particularly in Illinois.

Screening occurred so late, at least according to our scanty and contradictory data, that it is difficult to estimate its influence on the disappearance of malaria. Although our data on housing are also not very rich they seem to show a definite correlation between better houses and malaria decline in all states examined.

The influence of the increase in dairy cattle on the decline of malaria in Iowa, Wisconsin, and Minnesota is obvious even from crude statistics.

Increase in wealth also shows close time connections for all states except Illinois.

There seems to be no time correlation between the introduction of quinine and the decline of malaria, which does not exclude an indirect influence of quinine, as outlined above.

The climatic factor has, of course, been operative during the whole period.

We have thus tried to evaluate the different factors generally credited with the disappearance of malaria from the Upper Mississippi Valley, and we hope to have collected at least more, and more substantial, data on the subject than had been known so far. At the end of this examination, none of the factors can be singled out as the main or exclusive agent of liberation from malaria. While the stopping of population movement, the

shifting of settlements inland, better housing and increase in wealth seem to have acted in all states, cattle breeding appears to have had an enormous influence in Iowa, Wisconsin and Minnesota, while perhaps only in Illinois and in a limited area of Missouri, did drainage as an isolated factor play a certain rôle. It is impossible to decide whether one of these factors was necessary in the given situation because none is theoretically indispensable, malaria decline having occurred also in regions where at least one of them was missing. All the historian is able to say is that actually these factors (and perhaps others of which we are still ignorant), in the different variations and combinations described for the various states, are most likely to have brought about the changes.

Hackett says:

> Ignorance, poverty, and disease constitute the vicious triangle of human social inadequacy. An attack on any one of them helps to dissipate the other two.
>
> But the causes of malaria, at least, are in the main independent of the ignorance and poverty of its victims and can be separately handled.[1]

While the first part of this proposition seems incontestable, the second may at least be regarded as highly doubtful. It is perhaps natural and almost necessary for a successful activity in their respective fields, that the biologist should look at malaria as an entomological problem, while the health officer should see it only from the point of view of treatment or mosquito eradication, because only in these fields can they act; but the specialist neither can nor will explain the whole phenomenon. Epidemiological and historical research, embracing all aspects of the malaria problem, rather confirms the thesis of the fundamentally social character of malaria.

> There is one condition which is usually linked with intense malaria transmission and this is the pioneering phase of land occupation and development.[2]

The Upper Mississippi Valley seems to be and indeed is another classic example of this condition. Nevertheless, analysis of the liberating factors trespasses the narrower field of "pioneer malaria" as a number of them may also become operative in long settled countries.

Towards the end of this study it may be well to remember that malaria in the Upper Mississippi Valley was not killed by a single magic bullet; the monster was only put in chains, the links of which we have tried to study. Each link of the chain is important, and the breaking of one link may set free again the evil fiend.

[1] Hackett, 1937, p. 320.

[2] *Ibid.*, p. 90. Hackett refers here to Sinton's classic analysis of "pioneer malaria" in *L. O. N. Health Org. C. H.* / Mal. / 202 / 23 Mai, 1933.

SOME REMARKS ON MALARIA AND HISTORY

It is as a kind of epilogue that we briefly discuss the impact of our study on a historical problem which actually is rather a pseudo-problem. While even in the isolated West, Yandell in 1841 had very naturally explained the waves of malaria in the Roman Campagna by historical events,[1] 60 years later, under the influence of the recent great discoveries in the field of malaria, the causal nexus was reversed and we were made to believe that not history makes malaria, but malaria makes history. We were then told that the Greek and Roman, Ceylonese, and other cultures did not become more malarious because of their decline but that they declined because of malaria and that malarious countries could neither progress nor develop. Hardly anybody will deny the rôle malaria, as well as many other diseases, can play as a secondary factor in history; but of all monistic theories of history, this one certainly is so highly artificial that it would hardly be worthwhile even to mention it here, had not the promotors of the new gospel—Ronald Ross, W. S. Jones, and Angelo Celli—been truly great men in their own field, whose views inevitably found their way into almost every textbook.

We are, of course, not going to discuss here the whole theory, but just to what extent it is corroborated by the experience of the Upper Mississippi Valley.[2] It may be safely stated that there was hardly ever a region which seemed more predestined to be stopped in its development by malaria than the Upper Mississippi Valley. And this is what McCulloch actually prophesied in 1829. But we know what really happened.

"We hear of regions the development of which has been prevented or long retarded by malaria; but it is noteworthy that the progress of the States of the Middle West was not checked by malaria, although the pioneers of many States suffered severely from it" (Barber, 1930, p. 8).

Not that malaria did not contribute to the forming of customs and ideas in the Middle West. Not that it did not retard or stop local settlement. We have seen how it held people out of Illinois in the beginning of the 19th century. One of the main assets of Cincinnati on the other hand seems to have been its relative freedom from malaria. We know how

[1] Yandell, 1841, pp. 164 ff.

[2] See also Childs, 1940, p. 204, who has done the same for North Carolina.

Kentuckians streamed back from malarious Missouri in the 1820's,[3] we know that in the same period numerous settlements along the Missouri were abandoned for the same reasons,[4] that St. Louis experienced a period of decline, etc.[5] But these were only molecular movements without influence on the general march of events. It is on the contrary surprising how little malaria, objectively such a dangerous condition, impressed people; so little, that it makes the collection of malaria records today a rather strenuous task.

Of course, in overcoming malaria in the Upper Mississippi Valley there existed locally some great objective and subjective assets. We have repeatedly emphasized the climate, not too favorable for malaria. Of enormous influence was the uninterrupted influx of American and foreign settlers, driven by their own initiative as well as by the pressure of other immigrant waves behind them. While this movement partly made for an increase in malaria, on the other hand the region had not to rely on its own human reserves alone, and during decades, where one man was felled by malaria, another eagerly stepped in. Without this continuous immigration, the development might have been quite different. Eventually the social and political structure of the country was such that the mid-Western farmer, unlike the Italian, Balkan or Hindu farmer, profited directly from his labor; and the wealth he created, remaining largely on the spot, could play an active rôle against malaria.

There were also important spiritual factors in action. The disregard for human life, expressed in such disgusting phenomena as crime waves, lynching,[6] barbaric treatment of women in childbirth,[7] also made for disregard of malaria. By the better element pioneering was regarded as a kind of crusade.[8] And indeed in the superstitions and the strange and exalted religiosity of the pioneer, in his revivals and shaking, parallels which the crusaders do not lack (who knows if his religious shaking had not been unconsciously preformed by his daily malarious shaking?). Crusaders, of course, are not easily driven back just by a worldly disease. It is interesting that this stern puritan spirit was even at the basis of a particular malaria "theory," where cause and result were strangely reversed. Indolence was no longer a consequence of disease, but a predisposing cause.[9] As among the settlers there seem to have been a certain

[3] T. Flint, 1826, p. 207.
[4] Hall, 1830, p. 181; *Trans. Missouri State Med. Ass.*, I, 1851, p. 32.
[5] Rawlings, I, p. 31.
[6] Adams, 1939, p. 223.
[7] Wood, 1843, p. 138.
[8] Nathan Parker, Chicago, 1856.
[9] Zeuch, p. 475.

percentage of lazy individuals, and as almost everyone got the ague, even a kind of empiric proof of the thesis could be offered.[10] The former freedom of places from malaria was along similar lines interpreted as the consequence of a "more temperate mode of living" or "habits of great simplicity."[11]

It must also be remembered that people were continually sustained by authoritative predictions that malaria would eventually be overcome, predictions they had all the more reason to believe, as they had already come true in the older states. We have mentioned Volney's prophecy of 1795 that the West would be free from fever after a hundred years, a prophecy which has been realized pretty accurately.[12] Drake predicted the valley would be healthy once the stream was regulated.[13] Surgeon James Mann wrote in 1816:

> These Autumnal diseases which are now considered endemic in new settlements will vanish as the forests are subdued, and the marshes and swamps drained, while the husbandman will be remunerated by a two-fold reward—higher degrees of health as well as accumulation of wealth.[14]

Schoolcraft wrote in 1825 in Illinois:

> That time and cultivation will remove the causes of unhealthiness, is a prevalent opinion; that they will effect any visible melioration within a short period, is improbable.[15]

Eventually not the least of the effects of quinine and patent medicines were the reassuring psychological effect they had on the population.

The history of the Upper Mississippi Valley does not, of course, prove that there might not be a country where under certain general conditions malaria will stop progress, but it does show that in the conditions outlined above even a highly malarious region might march forward towards progress almost unimpeded by malaria.

[10] *Ibid.*, p. 261.
[11] Blane at Rawlings, I, p. 31; R. T. Gibbs at Fenner, 1851, p. 189.
[12] Drake, I, p. 388.
[13] *Ibid.*, p. 137.
[14] Mann, 1816, p. 110.
[15] Schoolcraft, 1825, p. 301.

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